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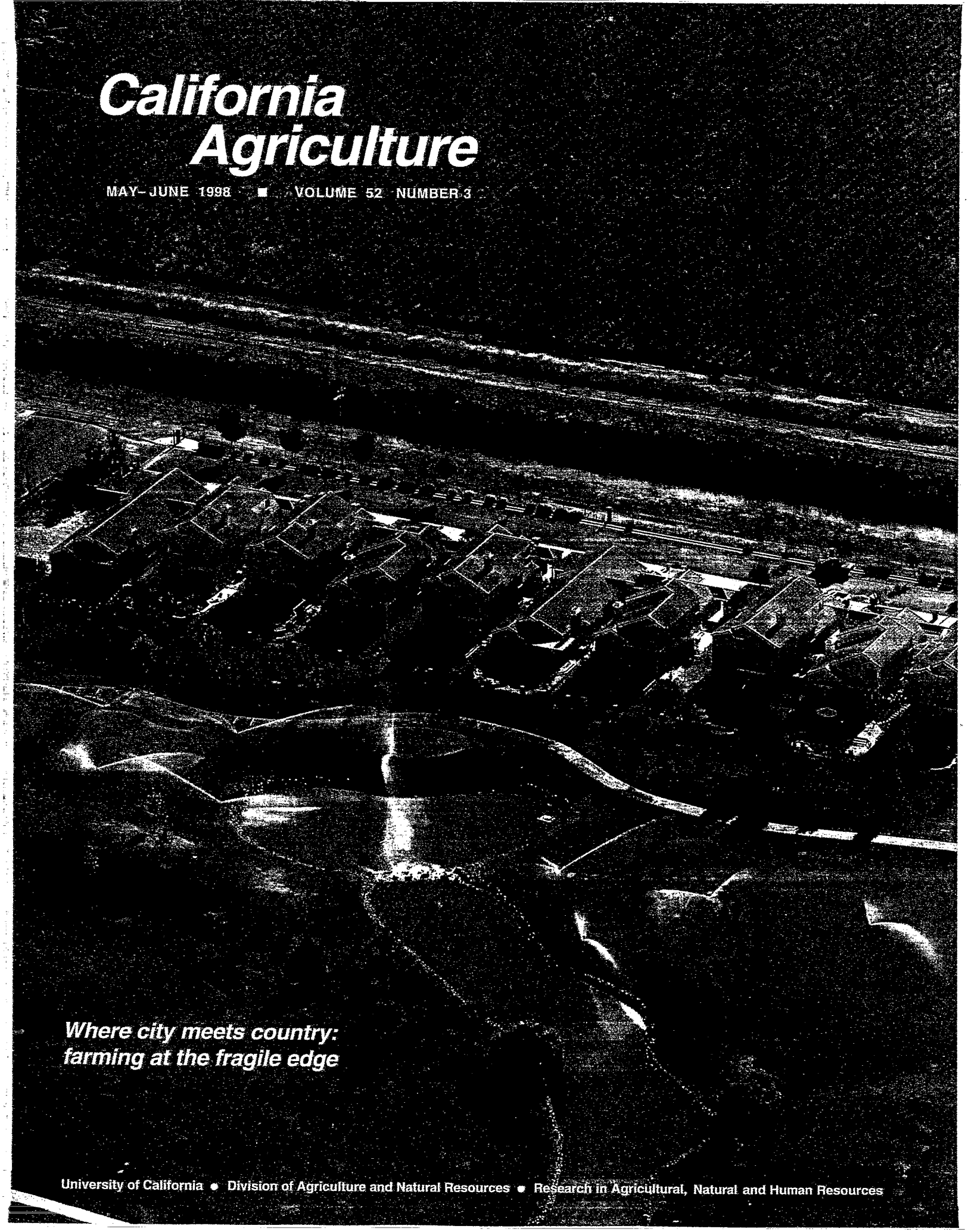

Where city meets country: farming at the fragile edge

University of California • Division of Agriculture and Natural Resources • Research in Agricultural, Natural and Human Resources

Steering a course to farmland protection

Alvin Sokolow
Public Policy Specialist
UC Davis

This issue of *California Agriculture* offers a small glimpse of a large problem — the urbanization of California farmland, a process which contributed to the 23% loss of this resource between 1950 and 1993.

The topic of farmland conversion often evokes emotion, speculation, and hand-wringing. Farmland suggests different images to different Californians. It can be any or all of these things:

- an irreplaceable natural resource,
- a type of industrial use,
- a generator of income and prosperity,
- a landscape amenity and antidote to urban congestion,
- an inefficient consumer of precious water, or
- a source of odor, noise and chemical danger.

If you are a farmland owner approaching retirement with a small income but a big property asset, your view of the resource quite naturally is different than if you are a suburban homeowner who likes the nearby farmland because it is pretty and adds to the rural ambience.

To the extent that the Division of Agriculture and Natural Resources (DANR) focuses on farmland-urbanization as a subject for research and education, we must steer an independent course through the thicket of conflicting views, values and personal preferences. We appreciate the critical contribution of good land to the viability of California agriculture, and we recognize the necessity of preserving for future generations the farmland base in this rapidly urbanizing state. But, if our objective is to inform policymakers and the public in a meaningful and credible fashion, we must go beyond the images and add to the factual understanding of the farmland conversion problem. This means examining the origins and dimensions of the problem, understanding its relationship to other resource and economic issues, and evaluating the feasibility of alternative solutions.

In at least three areas, DANR researchers and educators are making important contributions to resolving farmland-urbanization problems. One area is production agriculture research, carried out in laboratories and fields, which helps reduce the incompatibilities between agriculture and urban neighbors. This work includes myriad advances in integrated pest management, plant breeding and genetic engineering (leading, for instance, to disease-resistant varieties requiring fewer pesticides) and agricultural engineering to improve field spray technology, agricultural waste disposal and irrigation efficiency.

A second area is public policy research and education advanced by DANR social scientists. This includes the workshops and publications produced in the past decade by the Agricultural Issues Center on land use and urban growth issues. Among them are studies of the Williamson Act, Central Valley urbanization, and conflicts at the agriculture-urban edge.

Third is the educational work of Cooperative Extension advisors and county directors at the local level where land use decisions concerning farmland are made. Their expertise is sought on the agricultural consequences of urban development — as members of technical advisory committees that review policies and development proposals, as individual advisors to boards of supervisors and other county agencies, as cooperators on land resource issues with resource conservation districts, and as participants in public education projects.

The five articles and two sidebars in the special section address two separate but related public policy questions: (1) How do we minimize the conversion of productive farmland, while still accommodating the housing, economic and environmental needs of an urbanizing state? and (2) How do we reduce the conflicts and negative impacts at the farm-urban edge, making it possible for commercial agricultural and nonfarm residents to coexist peacefully in close proximity to each other?

The articles — condensed from chapters of an upcoming Agricultural Issues Center publication — deal with practical aspects of public policy: the effectiveness of state farmland protection, local government approaches to the same, the sources of edge conflicts, land speculation in agricultural areas in the path of urbanization, and the use of conservation easements by land trusts to protect farmland. Four of the five authors included in this section are not directly associated with UC, a reflection of the expert involvement in these areas by many other statewide and local organizations.

These papers barely scratch the surface of understanding the farmland-urbanization problem. The conversion and edge issues have multiple dimensions, some of which include water-land use relationships, the effects of farm family succession, and the validity of projections of farmland loss. We should also look into the effectiveness of different policies and techniques for minimizing the problem, such as higher development densities, better urban design at edges, conservation easements and urban limit lines.

All of this suggests an ambitious research and educational agenda that will carry us into the 21st Century. It is an agenda that cannot possibly be carried out by Division personnel acting on their own. It requires collaboration with other California institutions, including state and local governments, nonprofit organizations, industry groups, other universities, and other parts of UC. Farmland-urbanization issues are long-term concerns, important to California's future. In cooperation with others, the Division will continue to apply the fruits of new knowledge to these issues.

Special thanks to Al Sokolow, guest editor for the special section.

In this issue

SPECIAL SECTION
Where city meets country: farming at the fragile edge

COVER: The Discovery Bay development in Contra Costa County was initially approved for 3,600 homes. In 1996, the county approved an additional 2,000 units. The western edge of the development borders agricultural land. *Photo by Jack Kelly Clark*

CORRECTIONS: MARCH–APRIL 1998

The March-April 1998 issue of *California Agriculture* included incorrect captions on pages 14, 17, 25 and 26.

The photo captions on pages 14 and 17 were swapped.

The caption at the bottom of page 25 incorrectly stated that lanes 1 and 19 in panel B were positive controls (TYLCV-infected tomato tissue.) It should have stated that lanes 18 and 19 were positive controls.

The caption at the top of page 26 incorrectly stated: "Citrus tristeza virus is not a serious problem in San Joaquin Valley citrus, but could become so if the brown citrus aphid is introduced." It should have said, "Citrus tristeza virus has been controllable in San Joaquin Valley citrus, but may not be if the brown citrus aphid is introduced."

Also, photo credits were unintentionally omitted from some photographs in the same issue:

Jack Kelly Clark: all photos on pages 4, 5, 6, 13, 14, 15, 16, 17, 25, 44, 46 and the back cover.

Kenneth Lorenzen: all photos on pages 7, 8, 9, 11, and 12, as well as for the top left photo on page 10.

Harry Laidlaw: the top right photo on page 10.

Vernard Lewis: the photo at bottom right on page 35 and the photos on page 37.

We also wish to thank Robert Washino and Joe Morse who served as guest editor co-chairs for the March–April issue.–Ed.

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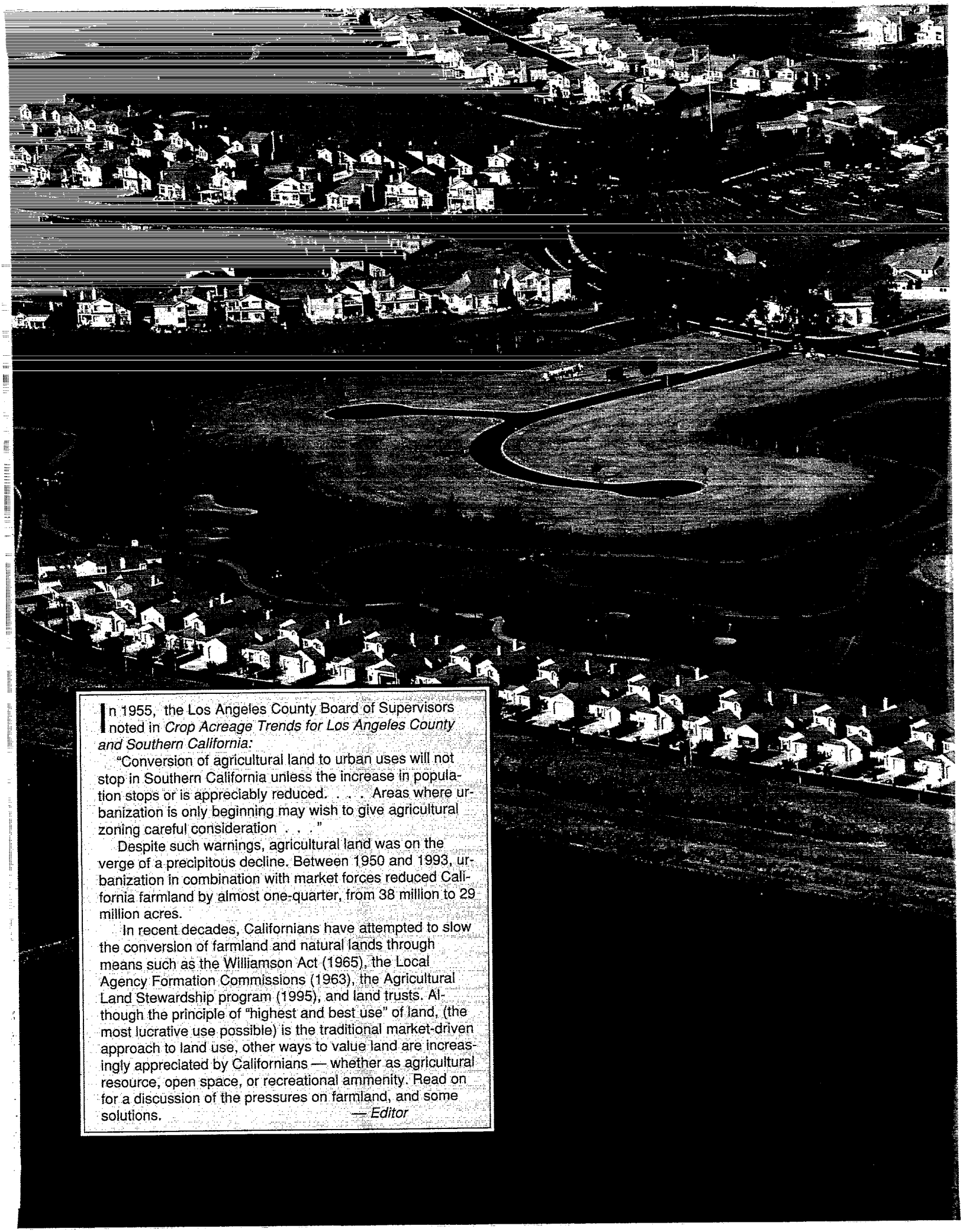


In 1955, the Los Angeles County Board of Supervisors noted in *Crop Acreage Trends for Los Angeles County and Southern California:*

"Conversion of agricultural land to urban uses will not stop in Southern California unless the increase in population stops or is appreciably reduced. . . . Areas where urbanization is only beginning may wish to give agricultural zoning careful consideration . . ."

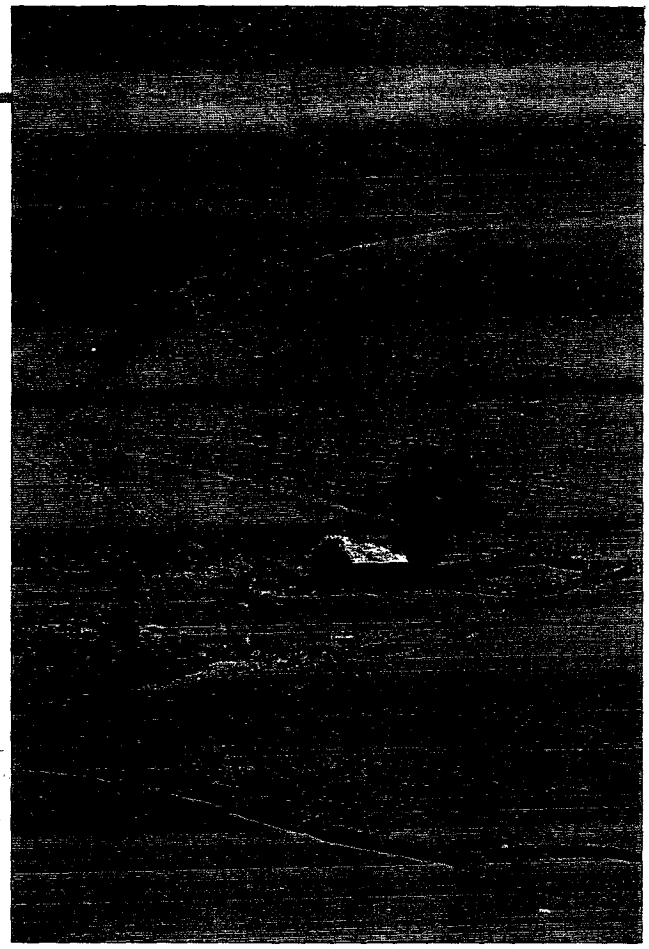
Despite such warnings, agricultural land was on the verge of a precipitous decline. Between 1950 and 1993, urbanization in combination with market forces reduced California farmland by almost one-quarter, from 38 million to 29 million acres.

In recent decades, Californians have attempted to slow the conversion of farmland and natural lands through means such as the Williamson Act (1965), the Local Agency Formation Commissions (1963), the Agricultural Land Stewardship program (1995), and land trusts. Although the principle of "highest and best use" of land, (the most lucrative use possible) is the traditional market-driven approach to land use, other ways to value land are increasingly appreciated by Californians — whether as agricultural resource, open space, or recreational ammenity. Read on for a discussion of the pressures on farmland, and some solutions.

— Editor

Statewide farmland protection is fragmented, limited

Steve Sanders



Courtesy of Greenbelt Alliance

In traditionally pro-growth Contra Costa County, 5,330 homes were planned for Tassajara Valley. Under pressure from community residents opposed to urban sprawl, developers withdrew their proposal in May.

Fueled by a search for affordable land to house 600,000 new California residents each year, conversion of farmland to development has proceeded at a rapid pace since 1950. The impact of growth and development on open space and agricultural land is a critical issue for a very simple reason: the areas best suited for cropland — those favored by good weather, flat terrain and access to water — are also the areas most in demand for new homes and businesses. If meaningful farmland protection is to be enacted, California's farm community itself must become more united and aggressive, forming a broad coalition with water suppliers, environmentalists, local officials, and business and community leaders.

California's population increased at a record-setting pace in the 1980s, growing 25% in one decade. The state's Department of Finance expects a net increase of 6 million residents in the next 10 years (Heim 1997) — more people with a growing demand for land development. Yet California is ill-prepared to manage the impacts of another burst of rapid growth.

Perhaps no component of the state's economy is at greater risk from growth than is agriculture. Farmland has been converted to development at a rapid clip. As urbanization proceeds, major conflicts arise. For example, the demands of a growing urban population and economy, coupled with a belated effort to reverse decades of ecological decline in the state's rivers, lakes and wetlands, has placed an enormous strain on scarce water supplies, creating pressure to divert water from farms in order to serve cities and the environment (Goldman 1991, Reisner 1997).

California's growth

California's farmlands face five major threats related to growth.

The loss of agricultural land. From the early 1970s through the present, between 50,000 and 100,000 acres of land were estimated to be urbanized annually in the state (Nisbet 1993,

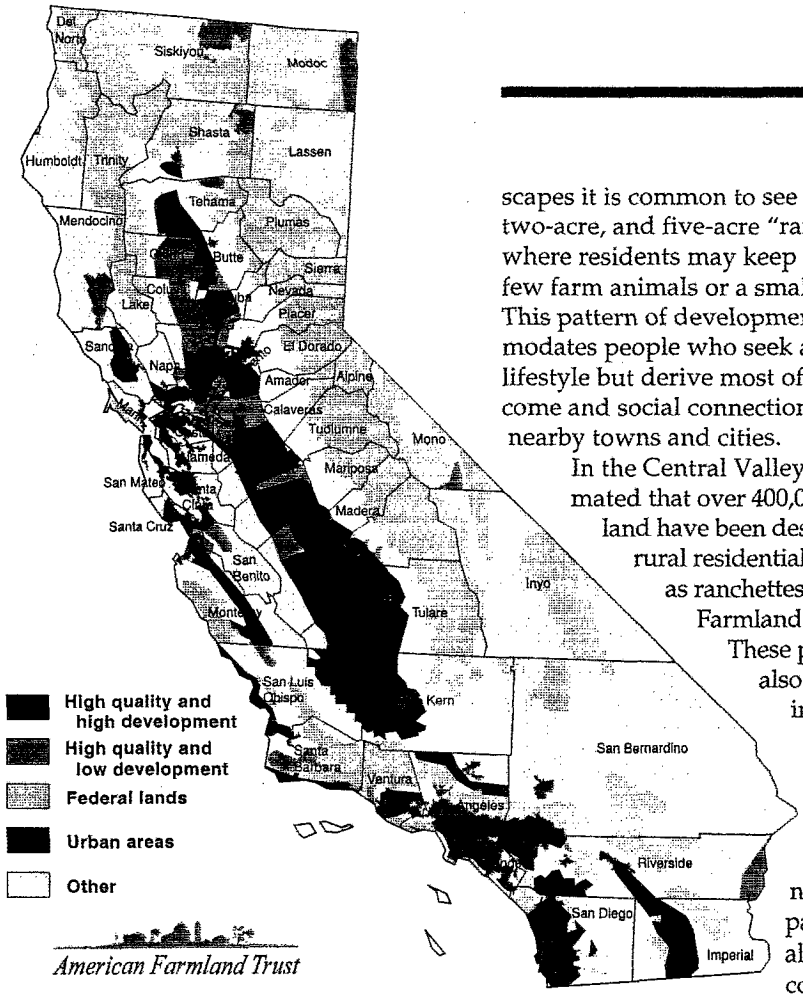
The Discovery Bay development and golf course abut Delta farmland; the state has recently created the Delta Protection Commission to stem farmland loss. *Photo by Jack Kelly Clark.*

THE LARGER COLLECTION . . .

The articles in this issue are condensed from several articles in an upcoming book, *California Farmland and Urban Pressures: Statewide and Regional Perspectives*, to be published by the UC Agricultural Issues Center later this year. Al Medvitz and Al Sokolow have edited the book, and its diverse authors include farm operators, citizen activitists, planning experts and UC faculty.

The larger collection will include 10 papers and an introduction. As well as expanded versions of the five papers and the sidebar on population trends in this issue of *California Agriculture*, the larger collection will include studies of (1) farmland politics in the Central Valley; (2) agricultural and land-use trends over time; (3) the politics of farmland protection in Napa and Marin counties; and (4) urbanization and natural resources in the northern Sacramento Valley.

To order the forthcoming book, call Sandy Fisher at (530) 752-1520.



This map highlights geographic areas using two threshold tests that define the importance and vulnerability of the land:
- **High quality farmland is that which in 1992 had relatively large amounts of prime farmland or specialty crop land.**
- **High development areas are those that experienced relatively rapid development between 1982 and 1992.**
- **Other areas are those that do not meet the two threshold tests, and that are neither federal lands nor urban areas.**

Grossi 1993). Much of this development occurred on cropland (see sidebar, p. 8).

In the 1960s, 1970s and early 1980s, most of the new development took place near the coast. In response, many agricultural enterprises fled the coast for the Chino Hills, Imperial, Riverside and San Bernardino counties, and the great Central Valley. Now, each of these areas is among the fastest-growing regions in the state, and California agriculture literally has nowhere else to go (Heim 1997).

The "rurbanization" of the working landscape. In many rural landscapes it is common to see one-acre, two-acre, and five-acre "ranchettes" where residents may keep horses, a few farm animals or a small farm plot. This pattern of development accommodates people who seek a rural lifestyle but derive most of their income and social connections from nearby towns and cities.

In the Central Valley, it is estimated that over 400,000 acres of land have been designated for rural residential uses, such as ranchettes (American Farmland Trust 1989). These patterns are also becoming increasingly common in the inland areas of Southern California and the pastoral areas along the coast.

As more people are introduced into an area, the conflicts between residents and the realities of farm life, with its noise, odors and chemicals, increase. Farm practices become more controversial and restricted. Land costs may rise, as the underlying value begins to reflect the higher return of developed uses, fostering yet more land conversion.

Water tug of war. There is general consensus that California has moved from an era of water development to one of water management (Goldman 1991, Reisner 1997). While some incremental increases in supply and conveyance facilities can be made, the water system we have in place today is the basic system we will have for the foreseeable future.

The result is a three-way tug of war between agriculture, urban centers and the environment for California's limited supply of water. As new water storage and conveyance facilities are built, old water supply contracts are renegotiated, and maintenance costs mount, the average cost of water delivered to the fields rises while the reliability of receiving full water delivery allotments declines. Cities can pay the price, especially when water is scarce, and spread it over their large rate-payer base. Farmers, quite often, cannot.

Public works paving the way for urbanization. Growth tends to follow the facilities available to service it (Misczynski 1987). The mere existence of a major public facility with unallocated capacity such as a freeway, water system or sewer system tends to act as a magnet for new development. Hence, large freeway interchanges in rural or low-density suburban areas accessible to existing urban centers become nodes for new "edge city" office parks and subdivisions, whether there was ever a plan or intent to urbanize the area.

In essence, public decisions on the size, character and location of major public facilities become a major determinant of future patterns of urban development. Because the potential impacts of these decisions on agricultural land are too often not understood or not considered by public officials, the long-term viability of the agricultural economy is placed at risk.

The very high initial cost of providing such facilities often forces the urbanization of the area, in order to provide the underlying economic value to pay for the facilities. This is especially true given current practices to pay for infrastructure through assessment districts, development fees and other value-capture mechanisms rather than general public revenues (Misczynski 1987, 1992).

Fiscal pressures for farmland conversion. California allocates property and sales tax revenue back to the local jurisdictions where they originate. Since these revenues are not allocated on a per capita basis, they may bear little or no relationship to the costs of providing needed services and facilities to accommodate development. The state has made matters worse by shifting a large and growing share of local property taxes from cities, counties and special districts to schools

(that share is now about $3.5 billion annually) — thereby relieving the state's General Fund of a large portion of its obligation to fund education as mandated under Proposition 98.

Local communities have used many strategies to respond to this dilemma, including a growing use of development fees, ballot measures to override tax and spending caps, and most importantly, competition for revenue-producing development. Counties and cities compete in an increasingly desperate effort to attract revenue-producing development with low service needs, such as auto malls and big-box retailers, while avoiding land uses that create ongoing costs for expensive public services, particularly housing affordable to middle-income or lower-income families.

This "fiscalization of land use" (Misczynski 1987) affects agriculture adversely in three ways. First, cities push to include large swaths of agricultural land in their spheres of influence (the area expected to eventually be incorporated within the city limits) so that they may be annexed in the future. This signals the market to raise land prices in anticipation of development, shifting the economic calculus away from long-term agricultural use (see p. 23). Secondly, as areas on the urban fringe are developed, farmlands are assessed part of the cost of infrastructure. This happens through rising property taxes (due to higher land values) and through assessments to pay for new infrastructure. All add to the economic pressure for conversion.

Finally, counties, which are usually the units of government most protective of farmland, feel obliged to engage in the development game as well, if only to preclude cities from capturing the economic windfalls (such as sales and propery taxes) while shifting the burdens (such as traffic and cost of infrastructure) to others. As a consequence, the commitment of county leaders to agricultural protection weakens over time as new areas of the county are opened to development.

Jack Kelly Clark

Farmers rely on an abundant supply of reasonably priced water. However, the average cost of water delivered to fields is rising while the reliability of receiving water declines. *Above*, a concrete irrigation ditch near Winters in Yolo County.

State policy responses

State policies for agriculture, open space and natural systems stress conservation. These policies can and do conflict with one another — such as restrictions on farming practices to protect endangered species, or diversion of water to farms that cause fisheries to decline precipitously.

Program responsibilities to carry out farmland preservation policies are divided among local communities (see p. 17) and the state. State responsibilities focus on data, review of local actions and funding for conservation programs. Local agencies are much more powerful, with direct authority to make land-use decisions and primary responsibility for implementing specific resource conservation projects and programs.

California's farmland protection

Direct land conservation is carried out primarily through local and regional agricultural land trusts (see p. 27). These trusts can purchase land outright, but more commonly acquire easements to preclude development on agricultural land. Proposition 70 of 1988 provided state bond funding to a number of land trusts throughout the state for these programs.

While some land trusts, such as those operating in Marin, Sonoma and Napa counties, have been successful in protecting locally important agricultural areas, land trusts to date have had only a minor impact on statewide farmland conversion. Well below 1% of California land is in public or private land trusts, and a small fraction of that is agricultural land.

Tax relief for agricultural property is provided through the Williamson Act, which assesses property taxes at a reduced rate on land which owners pledge to retain in agricultural use for 10 years. The rate reflects the land's value for farming rather than development.

While the Williamson Act provides a useful tool to encourage long-term agricultural use of the land and discourage leap-frog and remote development, the program appears to have had only a marginal success in stemming the conversion of the most vulnerable farmland to urban uses. Farmers may use the 10-year period to transition out of farming and into development, and much of the acreage enrolled in the program is remote

Urban growth squeezes agriculture

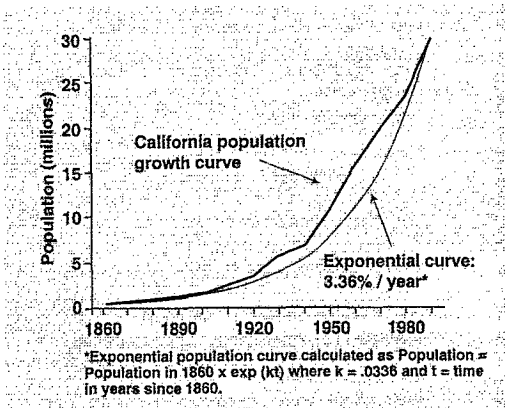
Albert G. Medvitz

A century ago, the state was populated by 1 million Californians — about the same number who now attend the Rose Bowl Parade every Jan. 1.

Today's state population is 33 times greater. The Department of Finance recently reported a 1.8% increase for the year ending July 1997 — 574,000 more people. The numbers signaled a resurgence of net migration and a continuing high rate of natural increase. The same figures showed that all but four counties grew, and Monterey and San Benito counties tied for the state's highest growth, at 4.9%.

Rapid growth is a century-long trend in California (fig. 1). Since the time of the Gold Rush, California's average yearly growth has exceeded 3.36% per year. Even when growth slowed during the recession of the early 1990s, California's fastest growing counties topped the growth rate of most countries in the world (table 1).

In recent decades, urban growth has led to farmland losses and changing economics for a number of farms. According to U.S. Bureau of the Census figures, the state lost close to 9 million acres of farmland between 1950 and 1993, a decline of almost 25%, from about 38 million to 29 million acres. As California's population continues to grow, so will urban land. By 2100, if current land-use patterns don't change, urban land in California could occupy one-third of the state — more area than is currently occupied by agriculture.



*Exponential population curve calculated as Population = Population in 1860 x exp (kt) where k = .0336 and t = time in years since 1860.

Fig. 1. California population growth, 1860–1990.

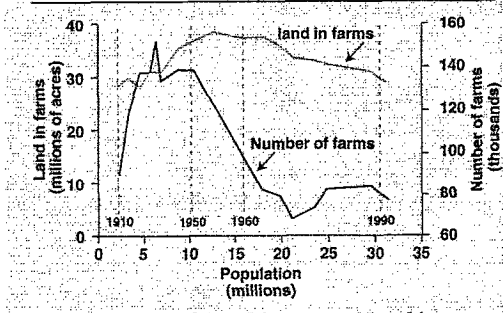


Fig. 2. Number of farms and land in farms versus population, 1910 to 1992. Source: U.S. Census Bureau, Censuses of Agriculture.

The reverse of a trend

For the first half of this century, farms and farmland increased along with California's population growth. But after 1950, the trend reversed. As population increased further, farmland declined (fig. 2). Urban populations moved into the agricultural mid-coastal valleys of Ventura and Monterey and San Luis Obispo and the fertile valleys east, north and south of San Francisco, dramatically transforming the landscape. Aerial photographs (see p. 9) show the consequences of this trend for the Santa Clara Valley.

Nevertheless, the volume of agricultural production has continued to increase to the present. Farmland losses were countered after World War II by massive irrigation projects such as the Central Valley Project, which allowed the expansion of intensive irrigated agriculture into otherwise arid grazing lands in the Southern San Joaquin Valley. Growers continued to adopt new technologies and crops, and further diversified, expanding from 200 commodities at the end of World War II to 350 crop and livestock commodities by 1996.

Despite increasing production, markets changed such that the value of the state's agricultural production experienced an extended decline after 1975, if figures are adjusted for inflation. In constant 1992 dollars, the 1975 value of production was $25 billion and the 1993 value of production was $18 billion. Production value has shown an upward trend in the past 5 years.

What lies ahead?

More recently, population has spread over the Tehachapis south of Bakersfield and over the coastal ranges into the fertile Central Valley. This time agriculture has nowhere to go. The children of dairy farmers who sold their San Bernadino operations and resettled in the Central Valley don't have the same options their parents had, because additional dairy land is not readily available in the state. Relo-

TABLE 1. Five-year average of population growth rates of selected countries, California and selected California counties, 1990–1995

Imperial	4.4*	Orange	2.0
Israel	3.8†	Bangladesh	2.0
Madera	3.5	India	1.9
Peru	3.3	San Bernadino	1.9
Saudi Arabia	3.0	Haiti	1.8
Nigeria	2.9	Brazil	1.6
Kenya	2.8	California	1.4
Afghanistan	2.8	Santa Clara	1.3
Riverside	2.8	Argentina	1.2
Zimbabwe	2.6	China	1.1
Kern	2.3	Los Angeles	1.0
South Africa	2.3	United States	1.0
Fresno	2.3	Switzerland	1.0
Vietnam	2.2	France	0.5
Tulare	2.2	Japan	0.3
Ecuador	2.1	Great Britain	0.3
Stanislaus	2.0	Russia	0.1
Mexico	2.0	Italy	0.1

* California and county rates, shown in blue, are mean yearly rates calculated for 1990–1995. They are somewhat less than 1980–1990 averages and are based on Department of Finance estimates rather than US census counts.
† Country estimates are 1990–1995 averages from the World Bank's *World Population Projections: 1994–95.*

cating orchards is no longer simple because there is less easily irrigated flat land.

In addition, there are no more massive irrigation projects to turn deserts into fertile plains. Finally, urban populations now wish to preserve landscape for aesthetic and recreational purposes, as well as to enhance habitat for native creatures, purposes which may not be compatible with productive agriculture.

We are not yet close to losing the state's agricultural productivity. With a $24.5 billion farmgate value in 1996, agriculture remains a vital industry, and with 68% of its production exported (55% to other states), agriculture is an important economic contributor to local, state and national economies.

But we are faced with the prospect of huge dislocations and management dilemmas. For instance, agricultural employment remains critical to the economies of certain regions, most notably the San Joaquin Valley, where farm-related industries directly employ 8.5% of the total employees in all economic sectors. Central Valley farmland is the target of much planned population growth. If current trends continue, almost one-third of its irrigated cropland could be urbanized by 2040 (see map, p. 20). How do we accommodate new people in agricultural areas and maintain our productivity? How do we plan and manage for a future with many more people making increasing and conflicting demands on the state's land resources?

If agriculture is to have a long-term future in this state, we must acquire a better understanding of local land-use decision-making, as well as how, when and where the state's population is growing, and its agricultural impacts. Only then can we provide research-based information that will enable localities to make effective decisions concerning this important resource.

A.G. Medvitz, a rancher in Solano County, has an Ed.D. degree from Harvard University in Administration, Planning and Social Policy.

from the urban edge where development pressures — and the benefits of the program — are greatest.

Constraints on incorporation and annexation of farmland are contained in the Cortese-Knox Act and other state laws. Many policies are directly and indirectly related to land conservation, including an explicit directive to protect farmland from unwarranted conversion.

These general state policies are overseen by Local Agency Formation Commissions (LAFCOs) in each county, composed of city, county and public members. However, LAFCOs have no direct authority over land use, and cannot override city or county decisions regarding development applications. Also, LAFCOs rarely reject an annexation or incorporation proposal championed by a local community based on its impacts on farmland, and become mired in controversy when they do act to protect agricultural land.

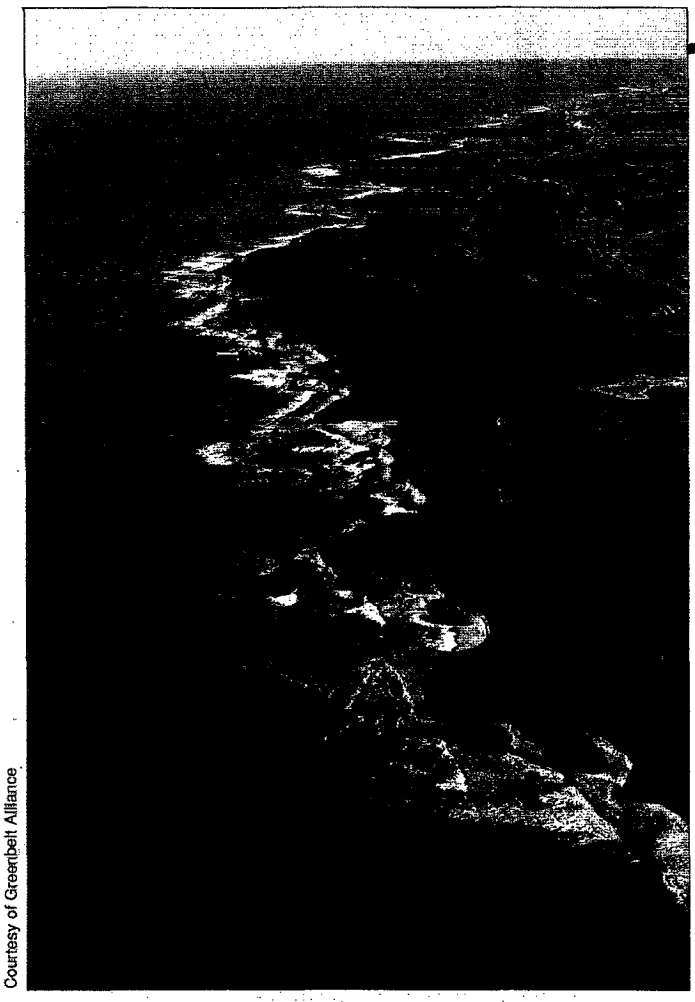
Courtesy of Agricultural Stabilization and Conservation Service

Courtesy of Agricultural Stabilization and Conservation Service

***Above,* Santa Clara County in 1950 is mainly fruit and nut orchards and a few row crops. *Below,* in 1980, the same land is covered by the rapidly growing suburbs of San Jose.**

Agriculture is typically included in the local general plan, in either the state-mandated land use or open space elements, or an optional agricultural element. However, state law does not impose any meaningful substantive requirements that local governments actually protect or preserve agricultural land in the face of development pressures. Instead, California's strong tradition of local home rule grants individual cities and counties wide discretion over land use and development decisions, which they often exercise to allow the conversion of farmland to urban uses.

The California Environmental Quality Act (CEQA) is perhaps the preeminent state environmental statute in the nation. However, the act has several weaknesses when it comes to protecting farmland. Farmland conversion per se is not considered a "significant environmental impact" under CEQA. As a consequence, many farmland conversion actions escape environmental scrutiny altogether. Even when significantly adverse farmland impacts are identified, lead agencies are free to approve a project by making a finding that the benefits of the project outweigh the impacts, or by deciding that alternatives to the project



Courtesy of Greenbelt Alliance

In 1986 San Mateo County voters approved a ballot measure to protect their coast, including local farms, from development.

or mitigation measures intended to lessen the impact are "infeasible."

Perhaps the state decisions most profoundly affecting farmland are those that impact the location, pace and timing of suburban and rural development and, with it, the pressure for farmland conversion. Such decisions concern water supply, water quality, freeway routes, university campus and state prison locations, priorities for school construction and renovation, and flood protection, among other issues.

For the most part, these decisions are made in an uncoordinated manner that lacks a unifying vision or comprehensive approach to planning and development.

The politics of farmland protection

Given the serious threats to the fundamental underpinning of California's $24.5 billion agricultural economy — the land itself — why isn't state government doing more to ensure a stronger and more effective state farmland protection policy? One key explanation is that the forces committed to farmland protection are too weak, fragmented, and isolated to secure sufficient political support for the enactment and effective implementation of meaningful farmland protection programs.

Perhaps most importantly, the agricultural community itself is split. While groups such as the American Farmland Trust and the California Farm Bureau Federation promote agricultural protection, individual county farm bureaus and commodity groups are often divided. Many farmers and their heirs see the land as their greatest asset, and are loath to give up the potential benefits of converting the land for development. Lacking a unified voice, agriculture is often in a weak position to advocate strong farmland protection measures at the state level.

Secondly, the economic and political power of the land development industry is formidable. Large sectors of the building industry have come to rely on the economic return that accrues from purchasing farmland cheaply and then persuading local officials to change the allowable uses.

Environmentalists are often at odds with the farm industry in California. Fights over water for farms versus water for fish and wildlife have been especially bitter, protracted and divisive. Disputes over agricultural runoff, pesticide use and agricultural burning only add to the animosity and distrust. These conflicts make it extremely difficult to establish farmer-environmentalist coalitions over farmland protection, even where common interests may unite these two constituencies.

Urban and suburban families in search of affordable housing are the driving force that fuels farmland conversion. While polls show that many city residents support saving farmland for the greenspace that open landscapes provide, city dwellers are often unprepared for the realities of living next door to a farm. Once they move in next to farming operations — unless there is a "right to farm" ordinance — such residents may file nuisance complaints about the noise, odors and other consequences of living on the ag-urban edge, further pressuring farmers to get out and sell the land for development. Often suburban community activists use "environmental" arguments to battle higher-density housing and mixed-use developments, thereby perpetuating low-density sprawl land-use patterns that consume more farmland.

Finally, urban water suppliers have a direct interest in expanding the supply of water available to serve growing cities. Acquiring water from agriculture in many cases is the path of least resistance.

Conclusions

For meaningful farmland protection to be enacted in California, the farm community itself must be more united and aggressive in advocating for protection. In this, the work of the American Farmland Trust, individual county farm bureaus, and articulate leadership within the California Farm Bureau Federation and other statewide agricultural associations is critical.

There are reasons to be cautiously optimistic that a statewide coalition to protect farmland could emerge in California.

In an effort to build consensus, Central Valley growers and industry representatives have recently formed the Agricultural Task Force, which has developed a package of policy positions on farmland and related issues.

Urban water interests could find value in an approach that would guar-

antee a reliable water supply to both cities and farms, in return for farmers agreeing not to develop their land.

Local officials and businesses could benefit from efforts that combined farmland protection with incentives for infill development and redevelopment in existing urban areas, if they were coupled with fiscal reforms to compensate for the loss of tax receipts and to ease the competition with other communities over the revenues from new development.

However, only modest and incremental change is likely unless there is new political leadership in Sacramento that is willing to tackle the economic, social and environmental consequences of rapid farmland conversion in the face of the determined opposition of most of the land development industry.

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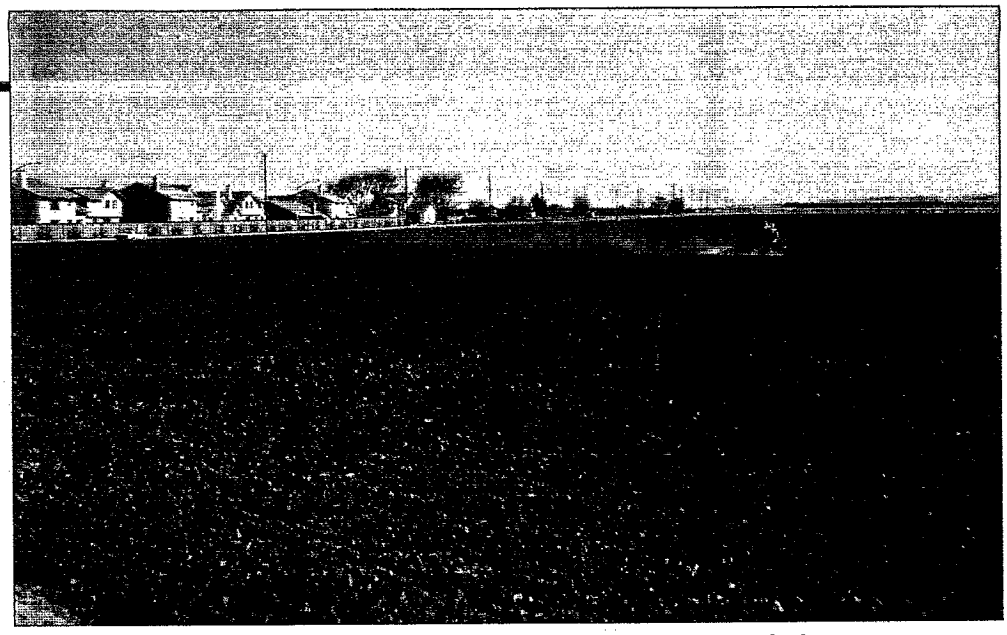


Jack Kelly Clark

As cities expand, urban residents are coming into closer contact with agriculture, as shown here near Modesto.

Conflicts arise on the urban fringe

Mary E. Handel

The frequent expansion of urban edges presents a challenge for California agriculture as the state's rich farmland base is consumed by nonfarm development. Some issues of conflict emerge as a part of the struggle for limited resources while others are related to the proximity of urban development and agriculture. Other conflicts reflect the urban resident's and farmer's different perspectives on the purpose or value of farmland. Local governments need to establish firm urban-growth boundaries, create buffers between agriculture and urban land uses, and zone to eliminate incompatible land uses in agricultural areas. For its part, the agricultural community needs to educate the urban public to help them understand why particular farm management practices are necessary.

The conflict between urban and agricultural land uses is intensified by the frequent expansion of urban edges into farmland. These unstable urban edges cause problems because urban residents and farmers have different perspectives on the purpose or value of farmland. Approaches to reducing this conflict include establishing firm urban-growth boundaries and better buffers to separate urban and agricultural land uses, eliminating incompatible uses in agricultural zones, and increasing the nonfarm public's understanding of farm management practices. These findings are from a study of urban/agricultural conflict and specific approaches that local governments have taken to reduce or eliminate the conflict in 16 California counties and several cities therein (Handel 1994).

California is the nation's leading agricultural producer and most populous state at 33.2 million and growing. Adding more than half a million people to the state each year increases the pressure daily for ur-

Mark Borba

Intruding urban residents have created new problems for farmers. *Above*, vandals caused over $80,000 in damage to three new cotton planters at a farm in Fresno County. The resultant delay in planting also cost this Riverdale grower $150,000 in yield losses.

Courtesy of Ag Alert

Ranchers are wary of dogs that run loose because some have maimed and killed livestock.

ban development on and adjacent to farmland.

Expanding city edges are a hot spot for urban/agricultural conflict because many of California's cities are surrounded by farmland and few have firm urban-growth boundaries. These unstable urban edges create an atmosphere of impermanence for California farmers: those not directly adjacent to cities today may find themselves there tomorrow. When farmers near the edge begin waiting for their time to sell out, they no longer have an incentive to invest in new farm equipment or long-term crops, or to adopt long-term production management techniques.

The edges of unincorporated communities are also hot spots for urban/agricultural conflict. The pressure to create commercial centers in unincorporated areas continues to increase as counties seek ways to generate more revenues in the post-Proposition 13 era, which cut property tax yields for local governments.

The third hot spot for urban/agricultural conflict is incompatible uses on land zoned for agriculture. The general plans of most agricultural counties allow nonagricultural uses on farmland including golf courses, recreational facilities, bed-and-breakfast inns, churches, schools and daycare centers. Besides creating conflicts with adjacent farmers, such incompatible uses can create new centers of development, making them an even greater threat to agriculture than the expansion of cities and unincorporated communities.

When urban development meets farmland, both urban residents and farmers suffer inconveniences. However, the fact that farmers suffer inconveniences is often forgotten by city planners, who give priority to the immediate comfort of the urban resident.

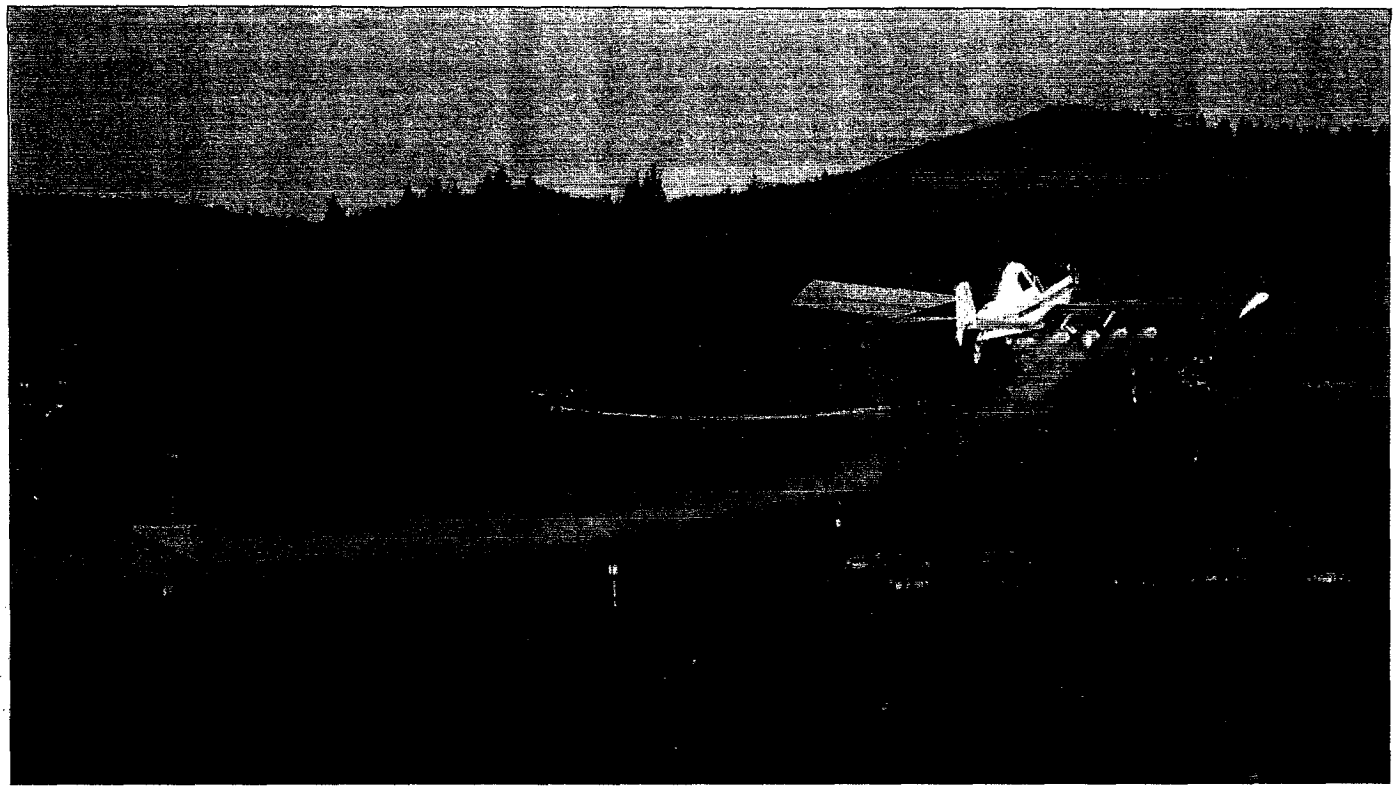
The urban perspective

Urban edge residents commonly complain about agricultural pesticide use. Neighbors adjacent to farmland fear that the pesticides used in agriculture put them at risk for chronic health problems. They do not trust the farmer's judgment regarding pesticide use and usually do not know what chemical is being applied or for what reasons.

Urban edge residents also commonly complain about agricultural noise. Most people think of the countryside as a peaceful alternative to loud cities. Their expectations are shattered when the neighboring farmer destroys the peace and quiet of the country, for example, by machine harvesting at night. Urban residents are particularly disturbed when farmers use aircraft because besides being noisy, air applications heighten concerns over chemical use.

Likewise, odors do not meet urban residents' expectations of rural living. Neighbors complain about odors from plant decay and dairy, poultry or other livestock operations. Livestock operations often also generate complaints about flies.

Urban residents also complain about the dust generated by disking, mowing or harvesting. Dust is an intrusion on their quality of life and in many cases may threaten their health.



Jack Kelly Clark

As subdivisions spring up around farmland, growers are forced to change their practices, such as curtailing aerial pesticide sprays.

Similarly, agricultural burning can destroy an otherwise clear day.

Finally, urban residents complain about slow farm equipment that blocks the flow of traffic. To many urban residents, the least the farmer could do is use the roadway only during noncommute hours.

The farm perspective

Growers often resent the sudden intrusion of urban residents who create the need for special management practices that may result in loss of crop productivity and add time, cost and labor. For example, pesticides that were used in the past may be prohibited and application by aircraft may be eliminated. Farmers also resent noise and odor complaints. They wonder why urban residents move to an agricultural area if they don't like the noises and odors associated with farming.

While urban residents complain about domestic flies, midges, mosquitoes and other pests from farmlands, farmers complain about pests from urban areas. For example, when subdivisions replace an orchard, any token trees left to justify the subdivision's name can provide a haven for pests. In addition, packs of dogs from neighboring subdivisions sometimes harass cattle or sheep.

While urban residents are impatient with slow farm machinery on roads, the increased traffic that accompanies urban expansion also causes problems for farmers. Trying to merge large equipment onto a busy roadway can be difficult and dangerous.

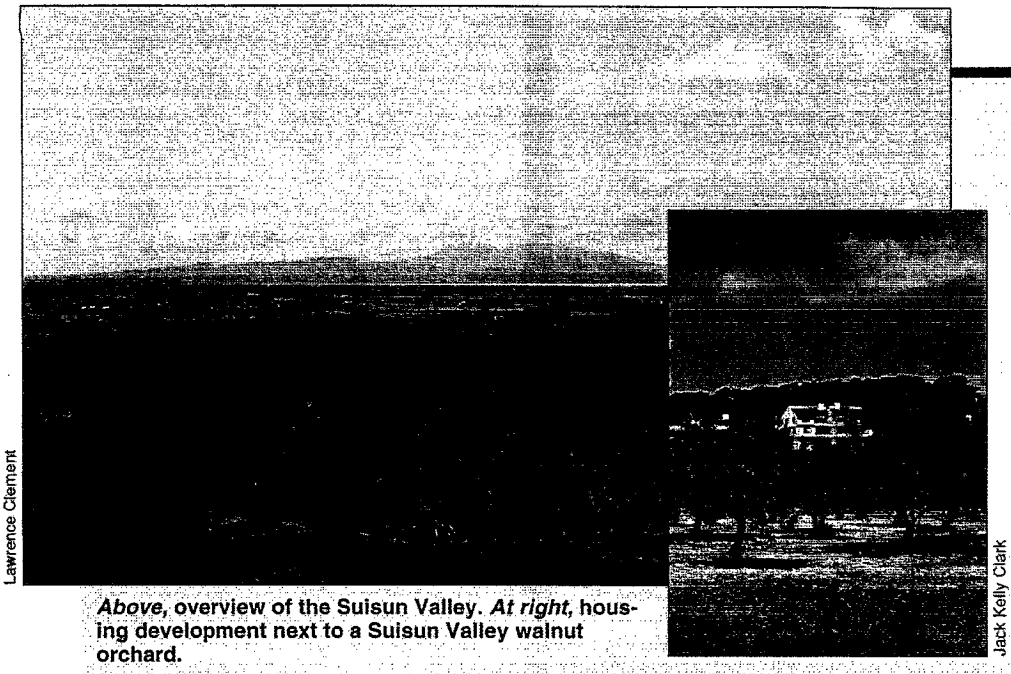
A chief concern of landowners is increased trespassing and the corresponding increased liability. As more people move into rural areas, orchards, grazing lands and reservoirs become enticing recreation lands.

According to a Kern County grower, "I used to let people picnic on my property. Families from Los Angeles County would drive here to spend an afternoon in the country, until one visitor broke his arm and sued me for $10,000. Now I have to chase people off my property because the liability is too great. Today a farmer could lose everything in one lawsuit."

An increase in urban residents also brings an increase in theft, vandalism and litter on farms. Most farm equipment is not under lock and key, and any equipment left in the field at the end of a day's work becomes a target for theft and vandalism. In livestock country fences may be cut and gates left open, allowing cattle or sheep to escape. Fencing to deter trespassers is costly and makes it difficult to maneuver equipment and move crops out of fields (California Department of Conservation 1991).

Influences on the conflict

A crop's layout influences both the level of inconvenience to nearby residents and the grower's ability to adapt to farming restrictions caused by urban encroachment. For example, while the best direction for planting crop rows is likely to depend on sun exposure and drainage, raising crops in rows that parallel the urban edge will be more convenient if the agricultural commissioner decides that the rows near the edge should not be sprayed. Then only the few rows near the edge will need special treatment, perhaps by hand. But if the rows run perpendicular to the edge, the grower will be required to drive the tractor and spray



Lawrence Clement

Jack Kelly Clark

***Above*, overview of the Suisun Valley. *At right*, housing development next to a Suisun Valley walnut orchard.**

Views in the Suisun Valley . . .

Rural dwellers divided on how to head off urbanization

Mary Handel ❑ Al Sokolow

The Suisun Valley in Solano County is one of California's most visible illustrations of competing land uses at the rural-urban frontier. This 10,000-acre area of small farms, rural homes and wooded hills is a prime target for urban development, due to its attractive amenities and proximity to millions of metropolitan residents. Located alongside Interstate 80 and adjacent to the rapidly growing city of Fairfield, the Suisun Valley lies directly in the path of intense urban pressure.

How do local people view the prospects of urbanization of the valley? And what do they think should be done about it, if anything?

Such questions guided a series of focus-group interviews conducted in late 1995 with 65 local residents, most of them Suisun Valley landowners. The project was planned as an informational contribution to further citizen and local government deliberation about the future of the valley. It was organized and carried out by a research team from UC Cooperative Extension, in cooperation with Solano County government. Organizers of the project and authors of the report are Larry Clement, CE director in Solano County; Al Sokolow and Joan Wright, CE specialists on the Davis campus; and planning consultant Mary Handel.

Overwhelmingly, focus-group participants liked living and farming in the area and preferred to maintain its rural characteristics. Yet, mindful of the pressures of urbanization from the adjacent city of Fairfield and the nearby Bay Area, more than half saw substantial urbanization as inevitable.

While some referred to expected reductions in the quality of life, such as increased congestion on local roads, most discussion about the impacts of urbanization dealt with impacts on the economic viability of local farming.

As to what, if anything, to do to head off the expected changes, residents in this sample were sharply divided between those who favored aggressive policy actions and those who disliked governmental action for this purpose.

About one-third were generally inclined to "go with the flow," expressing more passive views than others about future events and unsympathetic to planning and regulatory actions that restrict landowner options. Some participants in this category hoped to sell their property for development, although the dominant sentiment was more concerned with the inevitability of urbanization and oppositions to regulation.

The other two-thirds of the focus-group participants discussed two general approaches to protecting the valley's rural and agricultural characteristics: enhancing the profitability of local farming, and imposing additional land-use controls.

The participants suggested several ways of making local farming more profitable: direct marketing of farm produce, planting higher value crops, creating incentives to attract young people into local farming – such as technical assistance – and ensuring water supply at affordable prices.

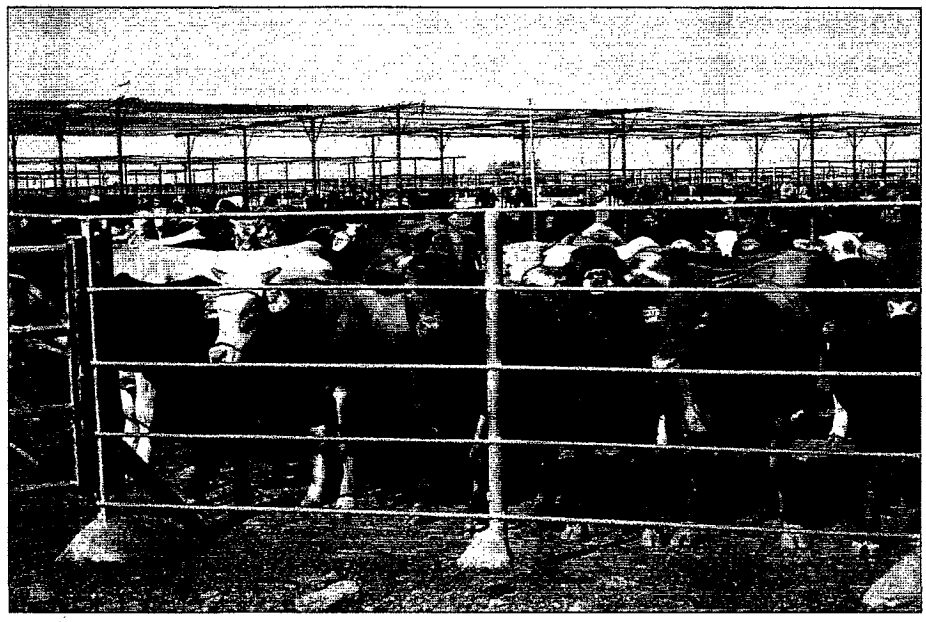
Suggested land-use approaches included giving permanent status to Measure A (a Solano County policy that limits development outside cities), zoning for larger parcels (the current minimum is 40 acres), purchasing conservation easements on farmland, creating a preservationist coalition, limiting the extension of public services to the area, and establishing an urban growth strategy for Fairfield that limits annexation and produces higher municipal densities.

Copies of "Suisun Valley and the Future: Focus Group Views of Farming, Rural Character and Urban Growth" are available from the UC Cooperative Extension Office in Solano County (Fairfield), (707) 421-6790.

rig down each row and turn off the spray machine before reaching each end. This wastes time and fuel running the tractor where the spray rig can't be engaged.

California's rapid conversion of farmland to houses usually brings an urban population that is generations removed from the farm. These new residents do not understand California agriculture and their attitudes about farming do not include tolerance of the inconveniences that come from normal farm practices.

As one agricultural commissioner noted, "They see blossoms and fields of mustard in the early spring and assume that this is what rural living is all about, but as summer approaches after they've moved into their new homes, the noise, dust and smells drive them crazy."



Suzanne Paisley

The bucolic scenery may draw people to rural areas, but they are not always enamored with the sounds and smells associated with livestock.

But urban attitudes toward farm operations are not always negative. Three cities in this study — Delano, Woodland and Petaluma — show that the rate and pattern of growth within cities influence the urban attitude toward adjacent farmland. For example, the Woodland Edges Project found that many of the residents of this Yolo County city have lived there a long time (43% had lived there for more than 25 years), and they generally expect that there will be some nuisances in a farming community.

Similarly, a city official from Petaluma in Sonoma County reported that few citizens there complain about agricultural practices because most people realize they live in a farm community. "Agriculture is an important part of the economy here," he said. One of the reasons so many residents understand the city's tie to agriculture may be that growth has been limited since the early 1970s, when Petaluma became the first community in the nation to establish an urban limit line and limit the number of permits for development projects.

Cities like Petaluma are the exception, however. Most local governments lack urban growth boundaries to stabilize the edge between urban and agricultural areas. They lack policies to restrict nonfarm uses from invading California's agricultural areas. Reducing the urban/agricultural conflict will require that local governments and perhaps the state government become more involved with growth management issues.

The value of farmland

Another major cause of the urban/agricultural conflict comes from the different viewpoints on the purpose or value of farmland. City and county decision-makers often view farmland as a provider of open space or as a land bank for future urban expansion. Urban residents often view farmland as a place for idyllic country living. To the farmer, however, farmland provides the means for making a living.

Several city and county general plans promote agricultural land as an open-space buffer between one community and another, between residential and industrial uses, and between airports and residential uses. Logan and Molotch note that California has some of the most productive farmland in the world, but when urbanization threatens that farmland, the public is concerned about losing open space rather than productivity (Logan and Molotch 1987).

Because open space is so desirable, houses on the edge next to agriculture are often more expensive than houses surrounded by more houses. Ironically, the urban edge's high property value may make the residents there more sensitive to inconveniences caused by agriculture. Edge residents accepted the high home price in exchange for peaceful rural living, but the adjacent farmer erodes the value of the investment with noise, smells and pesticides. The risk of losing an investment may explain why edge neighbors will fight the farmer with a lawsuit if necessary.

Farmland is also viewed by some cities and counties as a convenient way to hold land until the time for urban development. Most city planners recognize the convenience of keeping land in large parcels (agricultural parcels are usually 40 acres or more) at the city's edge so the land can some day be developed without existing structures blocking logical street, sewer and water extensions.

Farmers have been fighting the open space notion for some time. To the farmer, agricultural land is a resource for producing goods to sell. If a farmer can't make a reasonable living from this working landscape, it may

Jack Kelly Clark

The general plans of most agricultural counties allow nonagricultural uses on farmland, such as this driving range north of Stockton; such uses can create conflicts with adjacent farmers.

be converted to other uses including more urban development.

As several authors warn, "[t]here is no such thing as farmland without farmers. If nonfarmers are to enjoy the amenities of a working rural landscape, then they must either learn to tolerate farming practices or else settle at a distance from farm operations. The friction between farmers and nonfarmers involves a clash of property rights that cannot be resolved in the marketplace. Instead, legislative bodies and the courts must act as referees" (Lapping et al. 1989).

While farmers have helped change some general plans to recognize agriculture as an industry instead of simply open space, the concept of separating residential development from the industry of agriculture is only beginning to be recognized by some local governments as a legitimate concern.

Reducing the conflict

The decisions of appointed and elected local officials often reflect the nonfarm values prevalent in the general public because only 2% of California's population is directly involved in food and fiber production. However, viewing agriculture as an industry would make it easier for local planners and decision-makers to advocate land-use decisions and other measures that will help reduce the urban/agricultural conflict.

Local governments need to establish firm urban growth boundaries. Every time the urban edge moves, new farmers are suddenly faced with the same problems of farming next to the edge. Their frustration eventually leads to a desire to sell out to development and the cycle continues. Conversely, firm urban growth boundaries clearly distinguish land for urban development from land for agriculture. It helps remove expectations of buying "cheap" farmland for urban development. Conservation easements are a useful tool to help compensate the farmers at the edge.

Local governments also need to establish appropriate buffers between agriculture and urban land uses, and to clean up their general plans and zoning ordinances to eliminate incompatible land uses in agricultural areas. For example, because local governments allow houses on agricultural parcels, the potential for conflict is much greater when smaller agricultural parcels are created.

For its part, the agricultural community needs to make friends with the urban public to help them understand why particular farm management practices are necessary. Why, for example, do wind machines need to operate at 3 o'clock in the morning? Why do growers have to harvest at night? Why does rice need to be seeded with an airplane? Education efforts can help urban populations understand the industrial nature of farmland so their expectations of living in the country aren't contrary to reality.

Several farm organizations already dedicate time and money to this task, and some farmers are developing their own education programs by holding tours and field days at their farms and ranches. A few farm operators provide information to urban neighbors by walking the neighborhoods to inform residents of various management practices associated with their particular agricultural operations.

Reducing the urban/agricultural conflict will help us meet the challenge of maintaining our world-class agriculture in a state with a population growing faster than many Third World countries.

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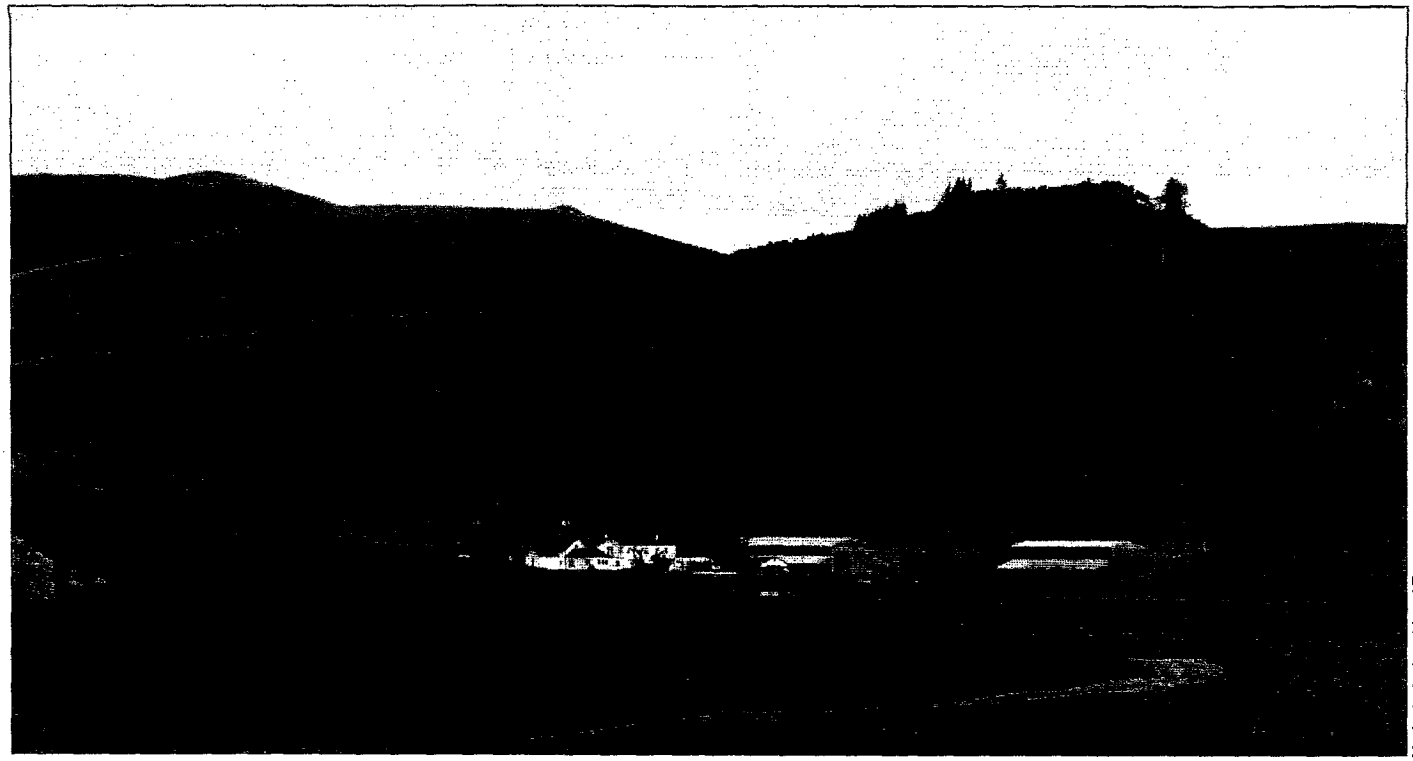
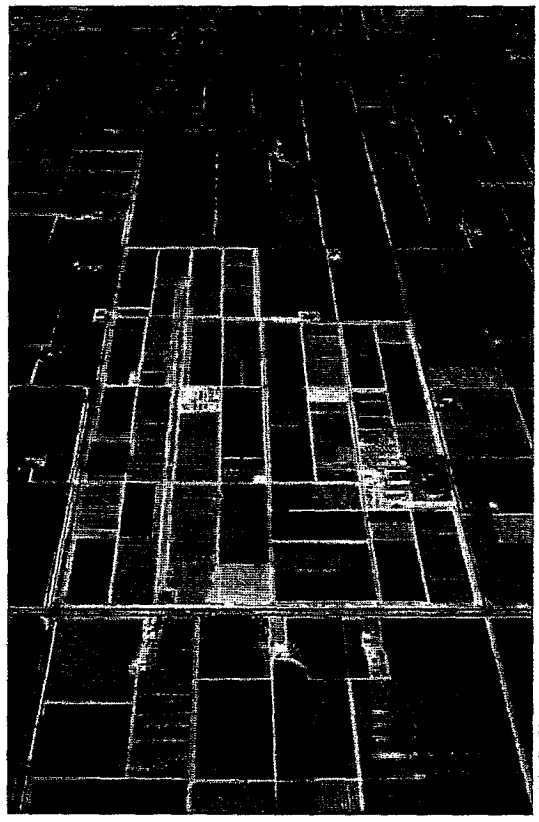


Marin Agricultural Land Trust

North Bay leads Central Valley in protecting farmland

Alvin D. Sokolow

North Bay residents are more active than Central Valley residents in protecting their farmland. One reason may be that farmland in the North Bay *(above)* appears to be finite, with most of it contained within small, green valleys ringed by soft hills, whereas farmland in most of the Central Valley *(below)* seems to stretch endlessly.



Jack Kelly Clark

In a comparison of four counties in the San Francisco North Bay area with seven Central Valley counties, researchers found that the coastal jurisdictions are more aggressive in limiting the conversion of farmland to urban uses and preserving open space. The North Bay counties make more use of innovative programs — primarily the acquisition of conservation easements on farmland by nonprofit land trusts and local governments, but also the adoption of growth boundaries. Local political variations account for much of these regional policy differences. Especially notable is the greater mobilization of conservation coalitions, including the more extensive use of the ballot box to protect open space, in the North Bay than in the Central Valley.

The 17-county Central Valley is the most productive and diverse farming region in the world, growing more than 250 commodities. Stretching almost 400 miles from north to south, the Central Valley has 14.5 million acres of farmland and accounts for two-thirds of California's total agricultural market value, which was $24.5 billion in 1996. By contrast, the nine-county San Francisco Bay Area has only roughly one-seventh as many agricultural acres and generated only one-eighteenth as much in farm market value in 1995. Even so, a number of Bay Area counties are more active than the Central Valley jurisdictions, and they lead the state's efforts to protect farmland.

We compared four northern Bay Area counties (Marin, Napa, Solano and Sonoma) with seven Central Valley counties (Fresno, Kern, San Joaquin, Stanislaus, Sutter, Tulare and

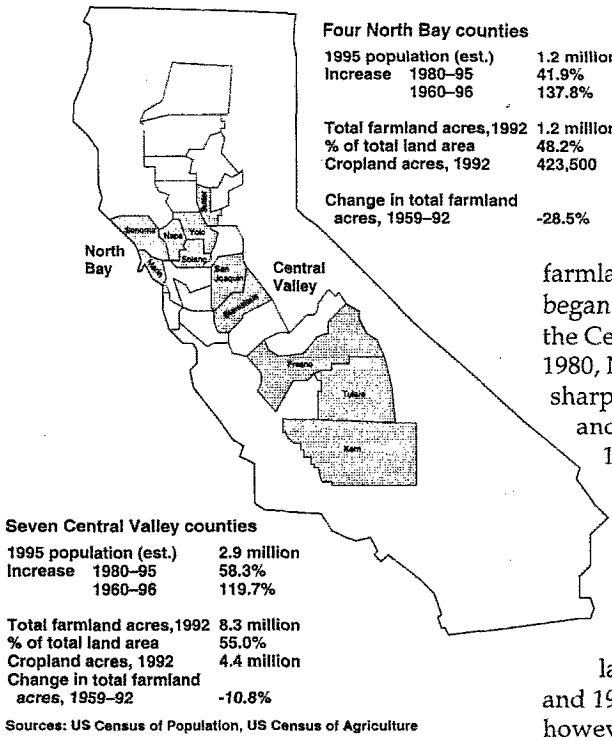


Fig. 1. Four North Bay and seven Central Valley counties sampled.

Yolo) (fig. 1), and found that the North Bay communities are more aggressive than those in the Central Valley in adopting innovative policies designed both to arrest the conversion of farmland to urban uses, and to preserve open space.

We drew from two studies: the first involved a review of farmland and open space policies in the four North Bay counties (Handel and Sokolow 1995), and the second was a broad examination of farmland policy in the Central Valley, supported in large part by the California Policy Seminar of the University of California (Sokolow 1997).

Population and farmland

Since World War II California has had a pattern of population increase and farmland decrease, but these trends began earlier in the North Bay than in the Central Valley. Between 1959 and 1980, North Bay counties experienced sharp population increases (67.6%) and farmland losses (26.0%). Since 1980, North Bay rates of both population growth and farmland loss have slowed (figs. 2 and 3). In contrast, the seven Central Valley counties had relatively low rates of population growth (38.8%) and farmland loss (8.2%) between 1959 and 1980. In the 15 years after 1980, however, population growth in the seven counties accelerated (58.3%) and the rate of farmland loss increased (about 10%).

Farmland protection policy

To protect farmland, North Bay and Central Valley counties apply a set of land-use and related tools that state law makes available to all city and county governments (Sokolow and Spezia 1993). Most of these tools are generic regulatory and planning mechanisms designed for managing urban growth. These are the most widely used:

- City and County General Plans: They usually outline farmland protection objectives.
- Agricultural Zoning: This specifies land-use restrictions such as homesite limitations and minimum parcel sizes.
- Williamson Act Contracts: The Act is a voluntary program in which farmland owners forego development in return for reduced property taxes under 10-year renewable contracts.
- Right to Farm Ordinances: Prospective home buyers in agricultural areas must be notified of the negative effects of nearby farming operations.
- CEQA Review: This environmental impact review is required for development proposals.
- LAFCO Review: Local agency formation commissions in each county approve municipal annexations and establish city spheres of influence for long-term expansion.

While the 11 counties we studied use all or most of the standard measures listed above, North Bay counties are also more likely to adopt other policy techniques that promise more permanent protection of farmland. In particular, all four counties have programs (operated by land trusts or local governments) that acquire conservation easements on farmland, thus preventing the urbanization of such parcels. Bay Area counties also have relatively firm limits on the location of urban development, expressed in general plans and the standards applied by LAFCOs to annexations and sphere of influence revisions. Urban limit lines are a popular technique, especially in Sonoma County where most cities have recently adopted such boundaries through the ballot box.

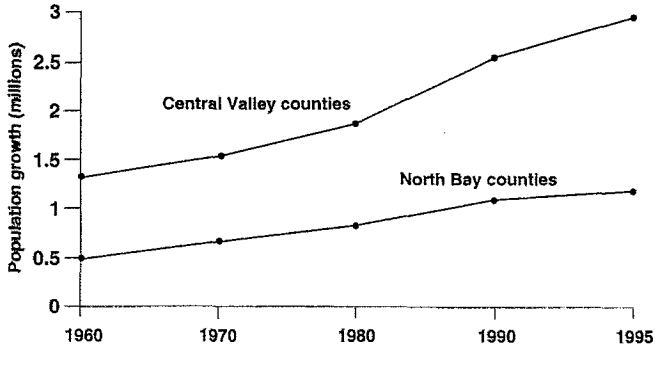


Fig. 2. Population trends in North Bay and sample Central Valley counties, 1960–1995. *Source: US Census of Population*

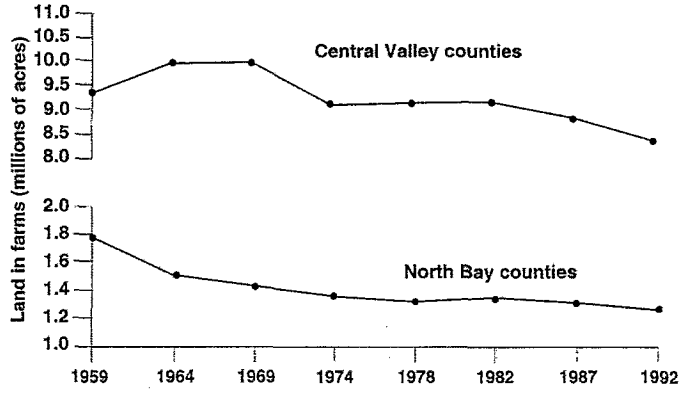


Fig. 3. Farmland trends in North Bay and sample Central Valley counties, 1959–1992. *Source: US Census of Agriculture*

Bay Area counties are also more likely to designate large rural areas for agricultural and other open space purposes. For example, in 1973 Marin County identified and continues to protect an inland rural corridor for agricultural and municipal watershed uses (Faber 1994) and in 1968 Napa placed most of its grape-growing valley into an agricultural preserve (Eisele 1994).

Conservation easements acquired in the past 20 years in the four North Bay counties preserve more than 60,000 acres of farmland and other open space (Handel and Sokolow 1995). The easements essentially protect land from urbanization for perpetuity and are typically created either through purchase or donation of the development rights by nonprofit land trusts or local governments (for a comprehensive review of California land trusts, see page 27).

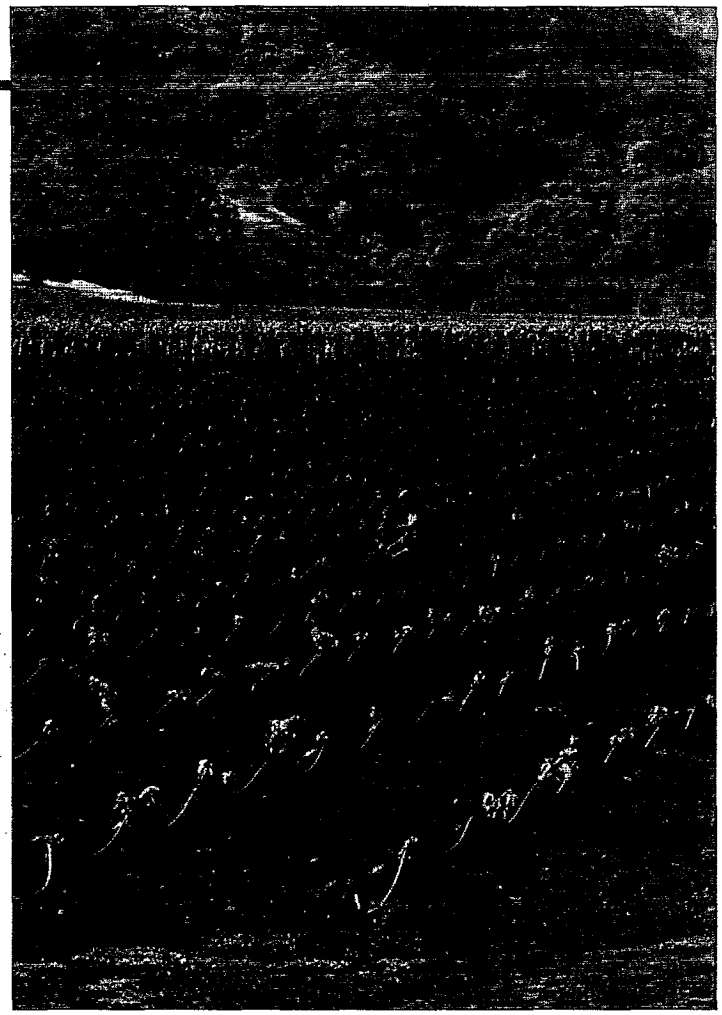
Sonoma County's program is the most ambitious in California and currently the most active local effort in the nation. In 1990 voters approved a quarter-cent sales tax for a 20-year period to fund the purchase of easements and established the Sonoma County Agricultural Preservation and Open Space District to carry out the program. The tax generates almost $10 million a year, sufficient to acquire several thousand acres of easements annually.

An older program in adjoining Marin County, the nonprofit Marin Agricultural Land Trust (MALT), has accumulated over 25,000 acres in easements since its founding in 1980.

In contrast, conservation easements are relatively rare in the Central Valley, where they are viewed cautiously due to their permanent nature. We estimate that the entire 18-county region contains only 3,000 to 4,000 acres of farmland in easements, although this preservation method is used more widely for wetlands and habitat protection. Interest in this compensatory technique is growing in the Central Valley, however. Since 1995, the Yolo Land Trust has acquired easements on six farm parcels, totaling 538 acres. Most are located between the cities of Davis and Woodland and were acquired as mitigation for the loss of other farmland through development in Davis. In 1996 a 1,000-acre easement on productive farmland along Interstate 80 was created by the western Solano County cities of Dixon and Vacaville to serve as an open space buffer between the two.

Central Valley variations

While the contrasts between the Bay Area and the Central Valley are striking, there are also significant differences in the ways local governments in the Central Valley deal with the pressures of urbanization on farmland.



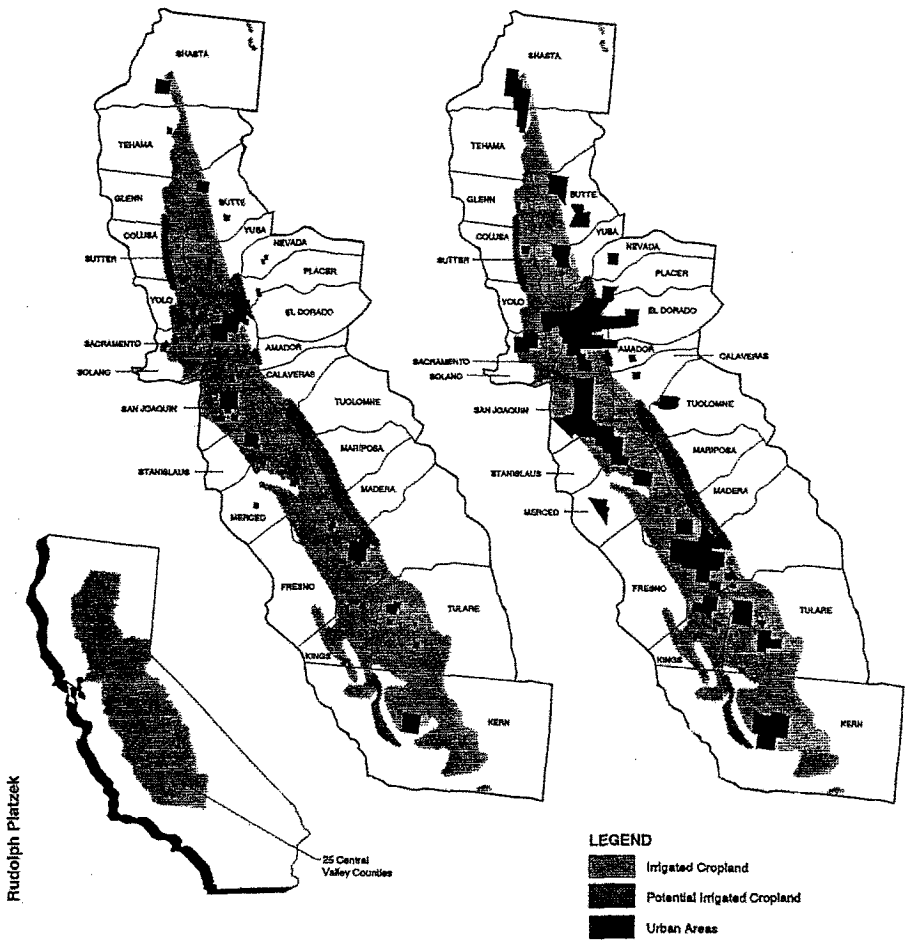
Jack Kelly Clark

Many Sonoma County cities have voted to adopt urban limit lines to protect vineyards and other farmland from urbanization.

Concentrating growth in cities. A major difference concerns the approach of county governments to the location of urban development, especially in relation to farmland in the unincorporated areas they control. Three of the Central Valley counties studied (Kern, San Joaquin and Sutter) are relatively tolerant of development in their areas, including large-lot rural residences. The other four counties studied (Fresno, Stanislaus, Tulare and Yolo) have firm policies that direct growth to cities (table 1). They do not entirely disallow development in unincorporated areas, encouraging growth in existing small population centers. Distinctions also are made between the more "productive" prime or irrigated cropland and other agricultural lands, primarily grazing and dryland crop acres. Tulare County, for example, encourages new development in its foothills, where relatively poor soils are prevalent.

County-city agreements. Four of the Central Valley counties — Fresno, Stanislaus, Tulare and Yolo — back up their growth location policies with referral agreements with their cities. These agreements allow a city to control developments proposed for the unincorporated fringes near its borders. Generally this means giving the city the option of annexing the property, applying city standards in anticipation of future development, or merely advising the county on appropriate actions.

These referral agreements are given teeth in Fresno, Stanislaus and Yolo counties by revenue-sharing agreements with their cities. The product of tough negotiations, these arrangements allow the counties to share in municipal revenues (including sales



Projected urban expansion on irrigated cropland in the Central Valley.

Retired urban and environmental planner Rudolph Platzek has estimated that, if current growth rates continue, the Valley's population will nearly triple between 1993 and 2040, rising to about 15 million. *Sources: Irrigated cropland information from California Department of Water Resources Bulletin 160-83. Urban expansion areas from* Alternative Futures for California's Central Valley, *Bob Grunwald, September 1993.*

taxes, hotel taxes, redevelopment revenues and increased property taxes) in return for not opposing city annexation and referring fringe development proposals to the cities.

Unique policy. Tulare County has a unique policy that stands out as a relatively serious effort to control farmland conversions. It is the only local government in California that regularly applies a precise set of standards to reviewing proposed farmland conversions. Under Tulare's Rural Valley Lands policy, each parcel proposed for rezoning within the county's western third or valley portion is evaluated according to 13 factors, including soil capability for crop production, parcel size and access to urban services. Depending on the cumulative number of points, a proposal may be rejected outright, automatically approved for rezoning, or subject to the discretion of the board of supervisors.

Adopted as part of the general plan in the early 1970s, the Tulare Rural Valley Lands policy offers a degree of quantitative objectivity that contrasts with the usual subjective processes by which governing boards and planning commissions generally make decisions about farmland conversion proposals. Over the years, the Tulare point system has clearly reduced the volume of conversion proposals within unincorporated areas: from 1986 to 1993 the county received only 30 conversion proposals concerning a total of only 353 acres with less than 200 acres rezoned for development. During the same period, the adjacent counties of Kern and Fresno each rezoned several thousand acres of farmland for development.

Urban mobilization and ballot box

More than simply the result of the acts of elected officials and their bureaucracies, farmland protection policies reflect the extent of citizen mobilization and electoral change. Variations in local political scenarios in fact help explain the policy differences between the North Bay and Central Valley counties.

In the North Bay, advocacy of strong farmland and open space policies in the years since World War II originated primarily among urban residents, many of whom are relatively affluent and conservation-minded (Handel and Sokolow 1995). A common rallying point for conservation advocates in all four North Bay counties has been the perceived threat of continued population influx outward from San Francisco and other core cities of the Bay Area. Such perceptions are more recent in the Central Valley and so far have not generated the same level of conservation advocacy.

The most important vehicle that North Bay conservationists have used to limit growth is the ballot box. Besides electing conservation-minded candidates to county boards of supervisors, voters enacted open-space measures through initiatives and referenda. Beginning in the early 1970s, each of the four counties adopted major farmland-protection and growth-limiting policies that originated with voter-approved ballot box measures (table 2).

Central Valley counties, by contrast, generally lack such voter-approved

policies (Glickfeld and Levine 1992). In fact, only three of the Central Valley counties studied have had growth-control proposals on their countywide ballots since the 1970s and all were defeated. And no Central Valley community has yet offered its voters a tax increase proposal for acquiring agricultural easements or other open space, such as were adopted in Sonoma and Marin counties.

The Central Valley lacks a regional conservation organization like the Bay Area's Greenbelt Alliance and few of its counties have local environmental groups active on land-use issues. Two exceptions are worth noting. In Yolo County, the Yolano chapter of the Sierra Club operates in unusual cooperation with the local farm bureau to develop mitigation policies for farmland conversions and improve the county's administration of the Williamson Act. In San Joaquin County, the Land Utilization Alliance (an organization of small farmers and environmentalists) frequently criticizes county and city growth policies.

Farm Bureau influence

Local chapters of the California Farm Bureau Federation and other agricultural organizations are the most influential private interests in initiating new farmland policies in the Central Valley. Local farm bureaus instigated the right-to-farm ordinances adopted by six of the seven Central Valley counties in the late 1980s and early 1990s.

The farm bureaus are the principal advocates for farmland protection in Tulare and Yolo counties, which not coincidentally have the strongest farmland protection programs in the Central Valley. Both the Tulare and Yolo Farm Bureaus regularly monitor county planning and land-use decisions. The Tulare Farm Bureau has pushed county officials to refine the innovative Rural Valley Lands Plan (which uses the point system to evaluate rezoning proposals) and has worked with LAFCO to establish firmer standards for city annexation

TABLE 1. Farmland policy emphases by seven Central Valley county governments

Fresno County
Direct urban development to cities. Limit rural residential development to parcels outside nonprime agricultural areas.

Kern County
As a resource to be protected, farmland is given approximately equal weight to oil and minerals. Allow development in unincorporated areas to provide a range of housing options. Emphasis on landowners' property rights.

San Joaquin County
Jobs and housing outweigh farmland protection as planning goals; a diminished economic role for local agriculture is projected for the future. No firm policy for directing urban growth to cities. Allow rural residential development.

Stanislaus County
Direct urban development to cities and to remote areas away from productive soils on valley floor. Allow development in areas with public infrastructure north of Modesto. Limit development in unincorporated areas elsewhere.

Sutter County
Allow development, including large-lot residences, in unincorporated areas. No policy of directing growth to cities. Emphasis on landowners' property rights. Increased interest now in farmland protection.

Tulare County
Farmland protection is the principal land-use priority. Direct urban development to cities and to less-productive soils in foothills. Limit rural residential development in unincorporated valley areas.

Yolo County
Farmland protection and open-space preservation is the principal land-use priority. Direct urbanization to cities; allow some development in unincorporated communities with economic potential. Limit severely rural residential development elsewhere and primarily to farm family members and employees.

Source: General plan language, interviews, newspaper accounts.

TABLE 2: Farmland-related measures on countywide ballots in four North Bay counties, 1972–96*

County/Date	Proposal	Result/Yes %
Marin		
November 1972	*Measure A:* Property tax for open space district program	Passed
June 1992	*Measure A:* Parcel tax to fund open space acquisitions and farmland easements	Defeated/61% (req. 2/3 approval)
November 1992	*Measure B:* Require countywide vote to convert farmland to urban use (initiative)	Defeated/37.2%
November 1996	*Measure A:* Quarter-cent sales tax to fund parks and open space acquisition	Defeated/57.5% (req. 2/3 approval)
Napa		
November 1980	*Measure A:* Limits residential development in unincorporated areas to 1% annual population growth (initiative)	Passed
November 1990	*Measure J:* Retains agricultural designations in existing general plan through 2020 and requires popular vote to develop in these areas	Passed/63.1% (initiative)
November 1992	*Measure N:* Creates Regional Open Space District	Defeated/33%
	Measure O: Quarter-cent sales tax for district programs (both initiatives)	Defeated/29%
March 1996	*Measure W:* Developer-initiated approval for large residential development—voter approval required under Measure J (initiative)	Defeated/16.3%
Solano		
June 1984	*Measure A:* Prohibits large-scale residential development in unincorporated areas (initiative)	Passed/50.3%
Sonoma		
November 1984	*Measure C:* Establishes agricultural production zones and calls for an easement purchase program (initiative)	Defeated/35%
November 1990	*Measure A:* Organizes Agricultural Preservation and Open Space District (initiative)	Passed/70%
	Measure C: Quarter-cent sales tax increase to fund easement acquisitions of district (initiative)	Passed/55%
March 1996	*Measure D:* Creates 20-year urban growth boundary	Passed/70%

*May not include all countywide ballot proposals during the period, and does not include city measures.
Source: Newspaper accounts.

Jack Kelly Clark

In the Central Valley, an estimated 400,000 acres have been designated for rural residential uses, much of that for large-lot ranchettes.

and spheres of influence. The Yolo Farm Bureau has sought a farmland easement program for its county and has been a prime mover in strengthening Williamson Act standards and revising LAFCO policies to clarify protection standards.

However, in some of the other Central Valley counties studied, the local farm bureaus do not have a common vision of protecting farmlands. Often, the members are divided — some support farmland protection whereas others emphasize more private property rights. Those in the latter group are reluctant to support regulatory measures for fear of restricting future landowner options.

Perceived value of farmland

While North Bay communities have been more aggressive about preserving farmland in the face of rapid urbanization, it is doubtful that policy lessons from this region can be translated easily and quickly into effective programs in the Central Valley. One reason is that the inland counties generally lack an engaged and organized conservation constituency that promotes successful ballot box measures and supports public funding for easement acquisitions.

Implicit in this regional political difference is a distinction in the perceived value of farmland. North Bay citizens in large part view their remaining farmland acres as an amenity, a form of open space that adds to their quality of life by providing a scenic antidote to urban congestion. By contrast, the prevailing Central Valley perspective is that the region's farmland expanses are primarily an industrial resource. These perceptions undoubtedly reflect the fact that farmland in the North Bay is attractive and appears to be finite, with most of it contained within small, green valleys ringed by soft hills and replenished by ample rain and coastal breezes. Farmland in most of the Central Valley suffers aesthetically by comparison — seemingly endless agricultural acres stretch to the horizon, baked into yellow and brown hues by the summer sun.

It would be erroneous, however, to picture Central Valley communities as insensitive to the farmland conversion problem. Many residents of the region are aware of the projections that estimate the conversion of more than a million acres of Central Valley farmland by 2040 under current land-use trends (American Farmland Trust 1995). Local governments there certainly are familiar with the range of policy options for farmland protection; some have adopted far-reaching policies and often reject specific development proposals that threaten agriculture. Whether they can be pushed further in this direction by local circumstances is the critical question for the future of California agriculture. No other areas of the state can support the large-scale farm production that would be displaced by extensive urbanization in the Central Valley.

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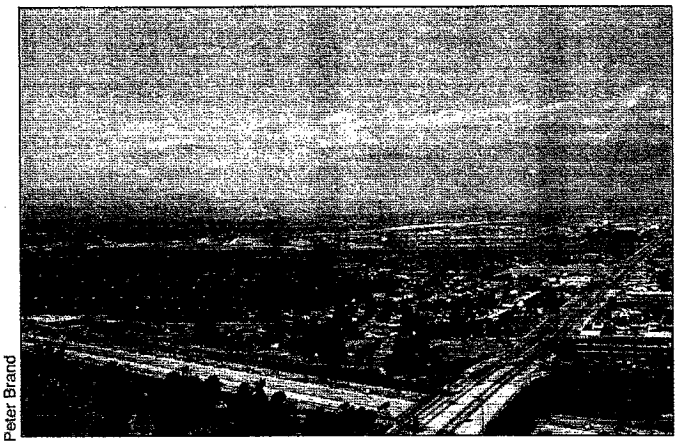


Peter Brand

Peter Brand

Above, **Oxnard's urban expansion is generating pressure to allow development of the area's greenbelts.** ***Right,*** **by contrast, citizens in San Buenaventura (the city of Ventura) passed an initiative stating that agricultural zoning can be changed only with voter approval. This cut flower farm thrives near the city's edge.**

Permissive growth policies may encourage speculative investment in farmland

Michal C. Moore

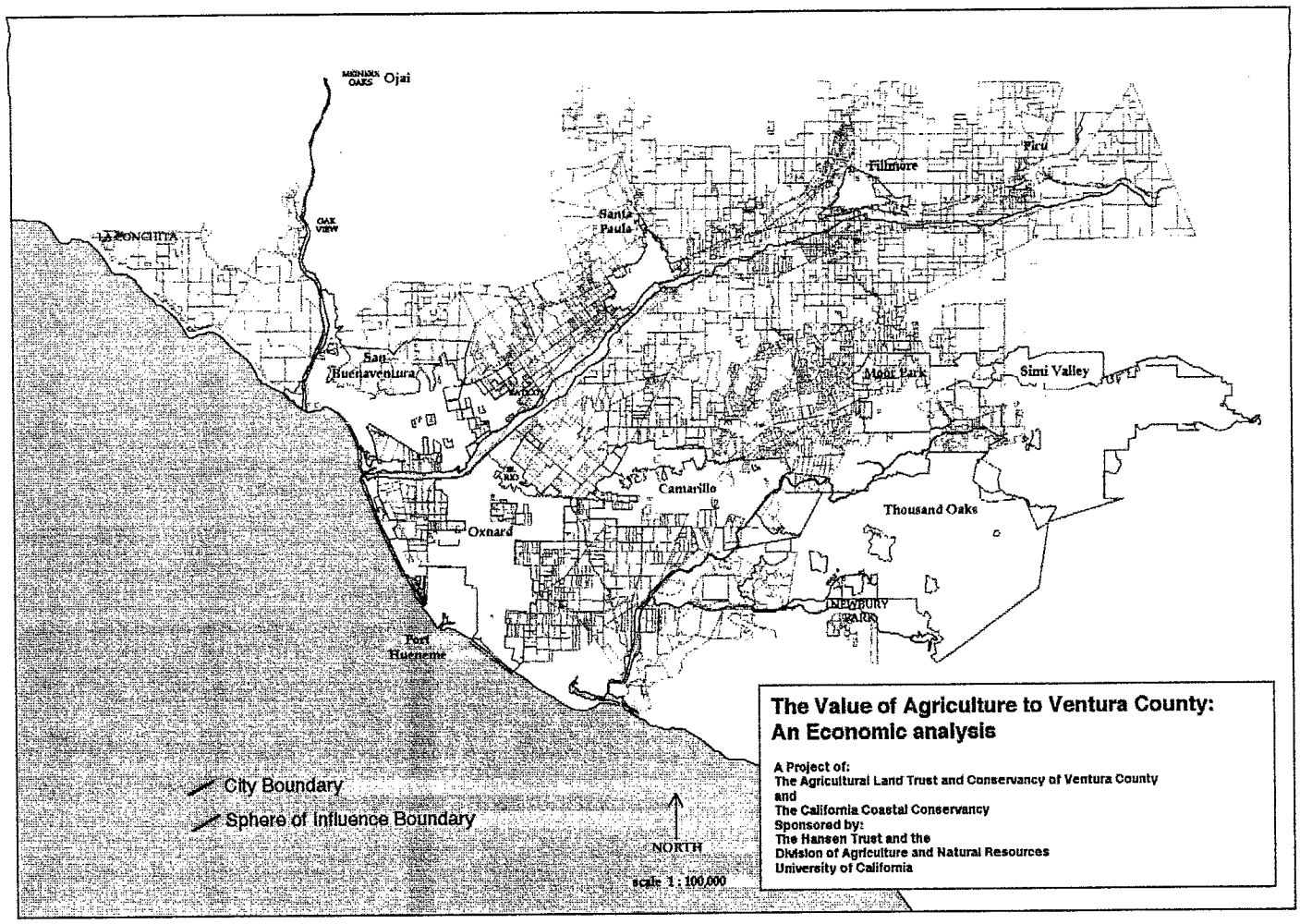
Agricultural land is at risk in much of California, especially near the boundaries of rapidly growing communities. A study of five cities in Ventura County, which is roughly 60 miles east of Los Angeles, strongly suggests that traditional policies for protecting farmland may be ineffective. These policies exist in tension with tremendous growth pressure generated both by local economic development policies and by urban expansion from the Los Angeles region. Development interests tend to bid on farmland in areas anticipated to be most susceptible to changes in land-use regulations.

While planners might believe that land market activities will be directed by farmland preservation policies, these policies are not always consistently applied by individual cities. And in municipalities that apply growth-control policies permissively, land speculators tend to bid up prices for parcels. In theory, greenbelts, the Williamson Act and spheres of influence protect agricultural land, sometimes in perpetuity. But a permissive approach toward development has encouraged speculators to bid up prices for "protected" land parcels in some areas. Land speculators may invest with the expectation of a return in a time period that is shorter than the expected life of the governing land-use plan. The power and preferences of the urban-conversion land market should not be ignored by local planners.

The impact of applying permissive growth-control policies on farmland near the urban edge is illustrated by the Ventura County land market. Ventura County has a rapidly increasing population as well as some of the most productive agricultural land in California, if not the world. Ventura County's microclimate and soils support a diverse range of crops from specialty fruits and nuts to double- and triple-row cropped vegetables. The more than 321,000 acres of farmland contribute more than $700 million to the local economy annually. Each of the five major cities in the county (Camarillo, Fillmore, Oxnard, Santa Paula and Ventura) is essentially surrounded by agricultural land, and each acknowledges the need to conserve this valuable resource.

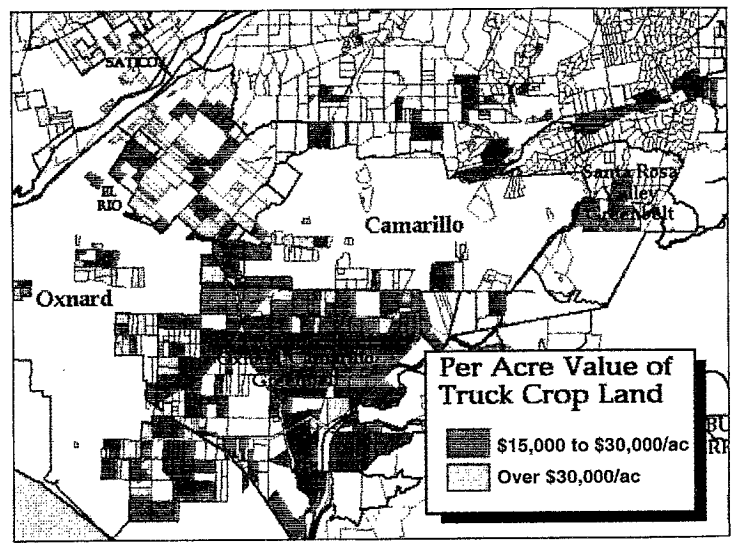
Ventura County is subject to a broad range of development proposals both because the area is desirable and because population growth spills over from the Los Angeles area. Between 1990 and 1995, the county's population and corresponding housing units increased 1.5% and 1.1%, respectively. Accommodation of the new growth has typically occurred through annexation and development of agricultural land adjacent to cities rather than through redevelopment of existing urban areas.

The market for land is guided but not determined by planning policies, especially where speculative investments are concerned. Speculation in land parcels is based on expectations or "hopes" of development opportunities that are not specified in the gen-



GIS maps courtesy of Stephen McNiel

The study area included most of the south portion of Ventura County. Note the differences between the existing city boundaries (brown lines) and the spheres of influence (SOI) boundaries (red lines).



Speculative land purchases are shown in light green. The pattern clearly indicates that parcels just outside the spheres of influence (SOI), the red lines, are assumed to be developable in the future by those who purchased these parcels. Note also that these speculative parcels lie within a designated greenbelt, illustrating the ineffectiveness of this zoning.

eral plan and that would typically generate higher future returns in the form of increased land value. Thus, land used for agriculture that is not presently available or zoned for development may still be subject to speculative bids designed to capture future values.

Land speculation is typically most prevalent in transitional or edge zones such as the urban/rural boundary. Speculative sales may involve a series of "strategic bids" by development interests on those areas anticipated to be most susceptible to changes within the controlling land-use regulations or plans. Anticipation of future bids may in turn presage requests for altering the basic municipal land-use plans, and may even precipitate changes in the plans themselves.

To protect farmland, Ventura County and each of the incorporated cities has created zoning designed to discourage the conversion of agricultural land to higher-intensity urban uses. Intensity denotes higher rent returns. In terms of investment, residential, industrial and commercial uses bring higher rent returns than agricultural uses. These policies, which include spheres of influence, are reinforced by the Local Agency Formation Commission (LAFCO), which has the power to grant or deny annexations to existing cities whether or not proper controls are maintained for agricultural land protection. In addition, the county has created long-term buffers to insulate

agriculture from urban pressure by designating greenbelts in cooperation with cities and by using the Williamson Open Space Act, which reduces property taxes for farmers who commit to long-term agricultural use on their properties.

Study data

This study focused on agricultural land sale prices near Ventura County's five major cities (Camarillo, Fillmore, Oxnard, Santa Paula and Ventura) as well as near five designated greenbelt areas. We hypothesized that prices for farmland of similar quality and characteristics would be higher near communities that apply growth policies more permissively, even when the same policy tools are used.

To ascertain whether city planning policies influence adjacent land market behavior, we correlated land prices with the application of three key planning tools: sphere of influence boundaries, which are commonly applied and adjudicated by LAFCO; greenbelt designations entered into by two neighboring cities and the county; and farmland enrollment in the Williamson Act within designated greenbelts.

We studied 3,000 privately owned parcels in Ventura County that were larger than 1 acre and contained productive agriculture. We divided the parcels into four categories: parcels lying totally within incorporated city boundaries, parcels within adopted spheres of influence, parcels outside the sphere of influence but within an arbitrary buffer zone of about 1/4 mile, and parcels within designated greenbelts. We also determined the parcels' proximities to sphere of influence boundaries, to city boundaries and, when applicable, to greenbelt boundaries.

Sphere of influence relationships

Acting generally as an extension of the adopted urban limit line, sphere of influence boundaries are designed to limit municipal expansion to a zone established by LAFCO to represent 20 years of future growth. Sphere limit lines are tailored to each community and vary in terms of absolute distance. The spheres define areas within which development and conversion of farmland is expected to occur some day. Beyond the sphere boundary farmland is expected to be insulated from development pressure. Intense development requests beyond the sphere line are not typically approved unless (1) modification of the sphere boundary is approved by LAFCO; (2) annexation to an existing city is anticipated; or (3) prezoning is approved. We hypothesized that if spheres of influence actually protect farmland, there should be little difference in agricultural land prices regardless of how far the parcel is from the outer edge of the boundary.

However, the sphere of influence boundaries appear to have been interpreted differently from what planners intended. Initially, we established that within the spheres, the closer a parcel was to a city in Ventura County, the higher the price (fig. 1). These expected price increases indicated that sphere boundaries artifically extended the influence of urban boundaries.

We also compared the value of the cities' sphere of influence lands to that of county land outside the sphere boundaries. Since planning rules do not allow development in unincorporated areas, the low average price per acre of county land is assumed to reflect the true value of land used only for agricultural purposes. The data show that the average price increase for sphere of influence land ranged from nearly 1.5-fold in the city of Ventura to more than 3.5-fold in Oxnard compared to land prices outside the sphere boundary (fig. 2). The highest sphere of influence land values were in Oxnard and Camarillo, the cities with highest rates of growth and expansion. While the highest values tend to occur within sphere boundaries, Oxnard, Camarillo and Ventura (which is also growing fast) also have higher than average prices for farmland outside their spheres of influence (fig. 3).

The difference in land prices outward from city boundaries showed

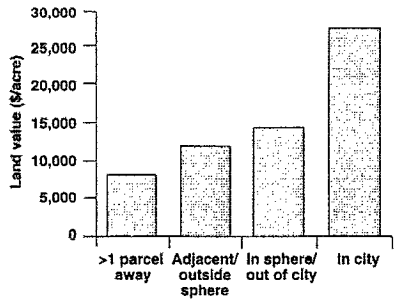


Fig. 1. Average of all city areas by sphere relationship in dollars per acre.

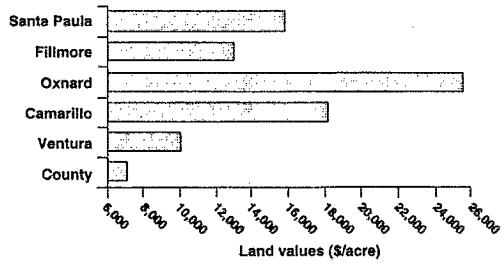


Fig. 2. Mean per acre land value within sphere but outside city boundaries. County land outside sphere of influence is the datum.

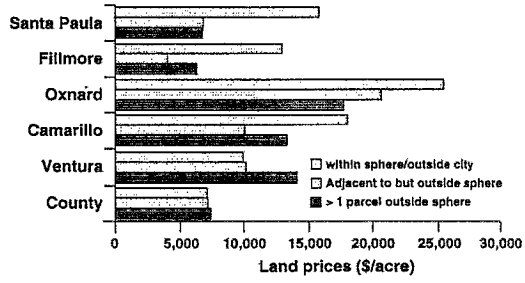


Fig. 3. Per acre land prices by city and greater county area with sphere of influence relationships.

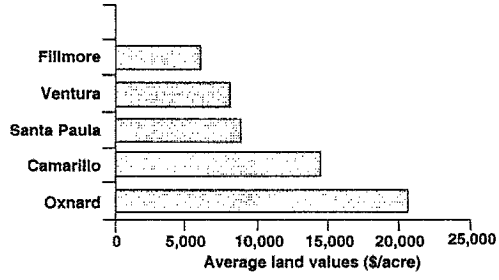


Fig. 4. Average per acre values for all greenbelt parcels by city proximity.

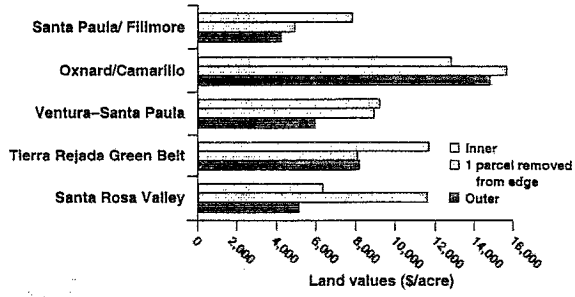


Fig. 5. Per acre values by greenbelt and by spatial location.

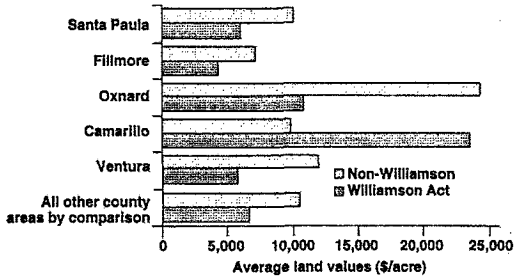


Fig. 6. Average per acre values in greenbelts by city proximity and Williamson Act contract.

higher land prices for similar types of parcels near urban areas with relatively permissive planning policy regimes. Thus, where more permissive planning policies are practiced, the sphere of influence boundary fails to provide a clear signal that development opportunities will not be allowed beyond the sphere boundary.

Greenbelt relationships

Local governments use greenbelts to buffer agricultural parcels from urban conversion. Often defensive in nature, greenbelts convey to the market that the public intends this area to remain in productive agriculture. However, if greenbelts do indeed protect farmland, land prices in different Ventura County greenbelts should be similar. However, this is not true in this case: the value of land in greenbelts is higher near cities with more permissive growth policies (fig. 4). Notably, greenbelt parcels between the fast-growing cities of Oxnard and Camarillo cost about three times more per acre than those near the slower-growing city of Fillmore. This suggests that application of land-use policies for each city are weighed in the context of land market sales rather than the preservation intention of the greenbelt designation. In other words, the simple designation of greenbelt does not guarantee farmland protection.

There is more evidence that greenbelts do not protect farmland from speculation. If they did, then parcels on the outer edge and in the center of greenbelts should be priced similarly by the land market. However, the price of greenbelt parcels varies with their location in the greenbelt. The values tend to be depressed nearest to the urban area, suggesting there is some influence of urban externalities on land values even in a protected zone (fig. 5) One implication of this is that it may be necessary to provide buffer zones between urban expansion areas and greenbelts to minimize negative externalities such as air pollution and vandalism.

These results show that the market appears to be getting signals that land in certain greenbelts and in certain locations within a given greenbelt may be available for development or other use potential beyond strictly agricultural uses at some point in the future. Higher land prices will ultimately translate into lower rent for existing or future agricultural uses because returns from agricultural production may not offset increased land costs in the form of debt payments. Consequently there will be increased pressure for change of land use classifications. In other words, when an agricultural parcel brings lower rent, the landowner is likely to press to have the parcel rezoned so it can be sold at a profit.

Williamson Act and greenbelts

The Williamson Act is a contract arrangement with landowners and municipal governments designed to offer tax relief for landowners who commit to long-term agricultural use on their properties. The Act is intended to encourage landowners to plan for stable operations. If the Williamson Act actually does promote stability in agricultural operations, three things should be true: (1) there should be higher rates of Williamson Act contract enrollment within greenbelts, since the combination of a tax break and greenbelt should provide an extra incentive for landowners, by assuring them that they can farm there for the long term; (2) within a greenbelt area, there should be no significant price differential between parcels enrolled in the Williamson Act and those that are not; this is because the Act should offer similar incentives to landowners as greenbelts, assuming that the greenbelts are perceived to be relatively permanent so land speculators won't want to buy either type of property; and (3) prices for Williamson Act properties should be similar in different greenbelts as well as at different distances from the edge of a given greenbelt.

In fact, the results suggest the opposite, that Williamson Act enrollment does not protect farmland. We did not find the condition where every property or even the majority of properties within greenbelts were enrolled. There is a clear price difference between Williamson Act and non-Williamson Act properties within greenbelts: the price of the latter is higher (fig. 6). In the case of Oxnard, one of the least restrictive cities in terms of planning policy, non-Williamson Act properties cost more than twice as much as Williamson Act properties. This inflation of land value reinforces the perception that development opportunities will occur near Oxnard in the future. These results suggest that the Williamson Act contract does send a clear signal to the market that these properties are intended for long-term agricultural use.

Williamson Act properties in greenbelts are priced about the same regardless of which greenbelt they are in or where they are located in a given greenbelt.

Enrollment in the Williamson Act in the county generally appears to coincide with the perception that planning policies will remain in force at least until the end of the current contract period. However, given the relationship of agricultural zoning to contract enrollment, there appears to be a very weak link at best between Williamson Act enrollment of land and planning policies. The strongest motive for enrolling would seem to be a defensive statement on the part of the landowners who intend to maintain agricultural uses on their parcels rather than sell to land speculators. There does not appear to be a clear incentive to enroll in the Williamson Act in the vicinity of cities, especially those with high growth development activities.

Policies may be ignored

This study suggests that the classic tools that California planners use to protect farmland may be only partially effective in deterring land speculators from buying agricultural land near cities. Policies designed to sustain and insulate viable agricultural zones (including spheres of influence boundaries, greenbelts and Williamson Act contracts) can have unanticipated outcomes when different cities apply them differently.

When cities tend to change zoning designations and planning restrictions, land speculators expect that given enough pressure, these policies will be altered in subsequent plan revisions. As a result, the speculative land market drives up the price of agricultural land near cities. One significant result of this is that farmland, traded for its agricultural production potential, cannot compete because the land is worth less when used for agriculture than for development.

The effectiveness of planning tools used by local communities needs to be re-examined: planners should develop alternative farmland protection policies that account for market forces. What we really need is a broad spectrum of new tools used in conjunction with zoning. This could include purchase or dedication of easements as well as more consistent application of zoning. What is missing is an appreciation of the fact that markets and market perception influences investment decisions. When the land market senses inconsistency or reversal of policy, speculations occurs, which spurs pressure to change plans. Without clear, consistently applied land-use policies, farmland will tend to act simply as a bank for future development opportunities.

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Marin Agricultural Land Trust

To promote public awareness of the importance of agriculture and the need to preserve it, the Marin Agricultural Land Trust gives tours of West Marin's farms and ranches. Rancher Richard Respini, center in blue jacket, talks to a tour group about the workings of his beef ranch, which is protected by a MALT agricultural conservation easement.

Land trusts conserve California farmland

Erik Vink

Communities can conserve farmland with land-use plans and zoning ordinances, but regulatory efforts are often transitory because future elected officials can revise them. To protect the land in the long term, agricultural land trusts work on a voluntary basis with individual landowners to acquire conservation easements that permanently restrict nonagricultural development of farmland. Farmers and ranchers are beginning to accept and support agricultural land trusts, which indicates that these trusts will continue to thrive.

As the nation's top-producing agricultural state and also the fastest-growing, California loses approximately 100,000 acres of agricultural land to urbanization annually. Because of the location of this growth, the state's best farmland is disproportionately affected, which has led to a strong public interest in protecting it.

Farmland conservation efforts have historically focused on land-use regulation by local governments. Local general plans and zoning ordinances have served to separate agricultural areas from incompatible land uses, such as urban uses where people congregate. While these regulatory efforts can be highly effective for a time, they are often transitory because the next group of elected officials can revise them.

The impermanence of regulatory efforts has led to a growing interest in efforts to protect farmland permanently. These efforts are carried out primarily by agricultural land trusts, which are private land conservation organizations. Agricultural land trusts work on a voluntary basis with individual landowners to acquire conser-

vation easements that permanently restrict nonagricultural development of farmland.

Land conservation organizations have been protecting important natural resources in California since the early part of the century. Until the mid-1950s, these organizations focused largely on protecting coastal land in Northern California. Today California has more than 115 land trusts (Land Trust Alliance 1995) protecting a great diversity of land types including wetlands, forests, trails, archaeological sites, sea dunes, riparian corridors and wildlife habitat. There is also an important — and growing — group of land trusts that focus on protecting the state's rich agricultural land. These are largely a result of the growing recognition that agricultural land's food-producing capability makes it an important resource.

Preserving farmland, open space

California has 14 agricultural land trusts (table 1) that are distinguished from other land conservation organizations by two primary attributes: the focus is protecting farmland and the governing board includes a strong representation of farmers. The state also has about 10 other land trusts that are working to protect farmland as part of larger efforts to preserve open space. Examples of these organizations include the Peninsula Open Space Trust, Sonoma Land Trust, Riverside Land Conservancy and the Land Trust of San Luis Obispo County.

Agricultural land trusts help conserve farmland primarily by acquiring interests in land, advancing policy efforts to protect farmland, and promoting educational efforts to highlight the importance of farmland.

Acquiring interests in farmland. While other land conservation organizations prefer to protect land by purchasing it outright, agricultural land trusts typically protect farmland by buying conservation easements or "development rights," as they are known in the eastern United States. Conservation easements are deed restrictions granted by a property owner to restrict the type and amount of development that may take place on his or her property (Diehl and Barrett 1988). Agricultural land trusts are primarily interested in prohibiting future urban development and leaving the land in private ownership and management to be farmed by a farmer. Thus, conservation easements can protect farmland without incurring the ownership and management responsibilities associated with outright purchase.

Land trusts can acquire conservation easements from landowners through either donation or purchase. When donated, the conservation easement's value (the amount by which the easement decreases the land's fair market value), is considered a charitable contribution by the Internal Revenue Service and so can be tax deducted. As an example, vineyard owners have donated conservation easements on several thousand acres to the Napa County Land Trust and the Monterey County Agricultural and Historical Land Conservancy.

Agricultural land trusts that have the funding to purchase conservation easements are the most successful at protecting farmland, largely due to the inability of most cash-poor, land-rich farmers to donate conservation easements on their land. When conservation easements are purchased, the landowner receives a cash payment for the value of the deed restriction. The most successful example of this

Table 1. Agricultural land trusts in California

Organization	Year founded	Area	Acres	Contact
Agricultural Trust of Contra Costa County	1997	Contra Costa Co.	0	Ed Meyer, Board of Directors (925) 646-5250
Marin Agricultural Land Trust	1980	Marin Co.	25,504(CE)*	Bob Berner, Exec. Dir. (415) 663-1158
Mendocino Agricultural Land Trust	1994	Mendocino Co.	0	Michael Delbar, Vice President (707) 743-2767
Merced County Farmland and Open Space Trust	1993	Merced Co.	0	Linda Macedo, President (209) 722-1372
Monterey County Agricultural and Historical Land Conservancy	1984	Monterey Co.	4,800(CE) 250(Fee)†	Brian Rianda, Board of Dir. (408) 422-5868
North Delta Conservancy	1992	SW Sacramento Co.	27(CE)	Catherine Baranek, Secretary (916) 775-1264
San Benito Agricultural Land Trust	1993	San Benito Co.	0	Paul Hain, President (408) 628-3390
San Joaquin Open Space and Farmland Trust	1990	San Joaquin Co.	0	John Schick, Secretary (209) 473-3290
Solano County Farmland and Open Space Foundation	1986	Solano Co.	82(CE) 4,779(Fee)	Pamela Mulck, Exec. Dir. (707) 428-7580
South Livermore Valley Agricultural Land Trust	1994	SE Alameda Co.	1,236(CE)	Pamela Wicinas, Exec.Dir. (925) 449-8706
Southern California Agricultural Land Foundation	1990	Chino Valley (San Bernardino Co.)	363(Fee)	Chuck Hale, Exec. Dir. (909) 464-0186
Ventura County Agricultural Land Trust and Conservancy	1992	Ventura Co.	0	Larry Rose, President (805) 647-2262
Yolo Land Trust	1988	Yolo Co.	538(CE)‡	Dave Scheuring, President (530) 759-0908
Yuba-Sutter Land Trust	1996	Yuba & Sutter cos.	0	Dale Whitmore, Advisor (530) 743-5068

*CE = Conservation easement
† Fee = Fee simple transaction, or outright purchase of the land.
‡ 813 additional acres in escrow at press time.

Jack Kelly Clark

Conservation easements are increasingly being used to protect land where high-value crops, such as strawberries, are grown.

effort in California has been the Marin Agricultural Land Trust's purchase of conservation easements that protect more than 25,000 acres of West Marin grazing land (Faber 1997).

Agricultural land trusts can also be granted conservation easements as mitigation when local jurisdictions allow nonfarm uses on other agricultural parcels. For example, under the City of Davis's 1995 Farmland Preservation Ordinance, developers who convert agricultural land to urban use are required to mitigate the farmland loss by protecting an equal area of remaining farmland with a conservation easement. These easements are co-held by the City of Davis and the Yolo Land Trust, and the Trust is charged with monitoring the protected farmlands to ensure compliance with the easement.

Policy efforts to protect farmland. As nonpolitical organizations working on a private and voluntary basis with landowners, land trusts are often "policy neutral" and rarely become involved in land-use decision-making. Some of California's agricultural land trusts are quite active in local policy efforts. Often these trusts are attempting to advance farmland protection efforts while they work to establish programs for acquiring conservation easement.

Another reason some agricultural land trusts are involved in local land-use policies is that they were formed in response to controversial land-use issues. The Land Utilization Trust, for example, was formed in 1992 in San Joaquin County to settle a lawsuit brought against developers by a local environmental organization. The Land Utilization Trust has been very active in general plan discussions for San Joaquin County and the City of Stockton, and has advocated farmland mitigation for general plan updates that would convert large tracts of farmland to urban use.

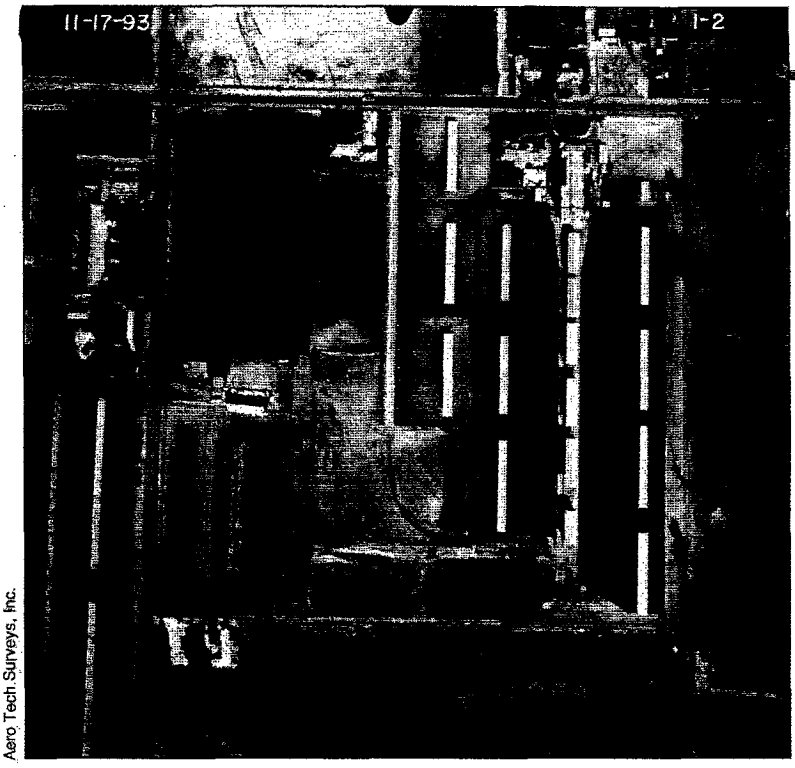
Educational efforts to protect farmland. All land trusts are involved in educational efforts, usually to inform landowners about conservation easements. This work is largely accomplished by producing and distributing brochures and pamphlets, and occasionally by sponsoring seminars explaining the tax implications of conservation easement sale/donation.

Some agricultural land trusts are also involved in more general efforts to educate the communities they serve about agriculture or conservation issues. This tends to be especially true for newer organizations that have not yet developed successful programs for acquiring conservation easements. Like nearly all fledgling agricultural land trusts, the North Delta Conservancy does not yet have much funding for acquiring conservation easements. However, the conservancy does have a very successful program that encourages landowners in the Delta region of Sacramento County to install wood duck boxes, which provide safe places for hens to incubate their eggs. This organization also focuses on educating schoolchildren about the agricultural, natural and historic resources of the Sacramento Delta region.

Agricultural land trust history

The first agricultural land trust in California — and in the nation — was the Marin Agricultural Land Trust, which was created in 1980. Several defining factors have played key roles in the establishment and success of the state's agricultural land trusts.

California State Coastal Conservancy. The Legislature created the State Coastal Conservancy in 1976 to protect, restore and enhance coastal resources. Established in the wake of the voter-approved California Coastal Plan, which mandated more land-use controls over coastal lands, the Conservancy offers property owners incentives to voluntarily participate in its conservation programs. The Conservancy is authorized to acquire interests in coastal agricultural lands, as well as nonagricultural lands, to keep them from being converted to other uses (Coppock and Ames 1989).



Aero Tech Surveys, Inc.

The Southern California Agricultural Land Foundation bought this 40-acre Chino Valley dairy to protect it from development in Southern California. The foundation leases the dairy and puts the profits toward property management and future land acquisitions.

In 1979 the State Coastal Conservancy adopted agricultural policy criteria that signaled its intent to provide funds to nonprofit land trusts to carry out conservation activities consistent with its mission. In 1984, the State Coastal Conservancy approved a $1 million grant to the Marin Agricultural Land Trust for a demonstration project to protect West Marin ranchland. The conservancy also approved similar grants for projects in Monterey and Sonoma counties.

Subsequently, the State Coastal Conservancy also provided financial support for coastal farmland conservation efforts by other organizations including the Peninsula Open Space Trust, Land Trust of Santa Barbara County and Sonoma Land Trust. By supporting coastal farmland conservation, the conservancy inspired the creation of agricultural land trusts in places such as Monterey and Ventura counties.

Proposition 70 (California Wildlife, Coastal and Park Land Conservation Bond Act). Approved by California voters in 1988, Proposition 70 included $63 million for farmland protection activities in eight California counties (primarily for Marin, San Bernardino and Riverside counties, with lesser amounts for Monterey, Santa Barbara, Santa Cruz, San Mateo and Sonoma counties). Besides providing a tremendous boost to fledgling agricultural land trusts, Proposition 70 signaled that organized land conservation efforts in any part of California might benefit from funding in future state general obligation land-conservation bond measures. This was no small factor in the subsequent establishment of a number of agricultural land trusts throughout California, such as the Yolo Land Trust and the San Joaquin County Open Space and Farmland Trust.

Release of reports/calls to action. Several agricultural land trusts were created in response to reports calling for their establishment. For example, a 1989 American Farmland Trust report called "Risks, Challenges and Opportunities: Agriculture, Resources and Growth in a Changing Central Valley" was instrumental in the establishment of both the San Joaquin Open Space and Farmland Trust and the Merced County Farmland and Open Space Trust.

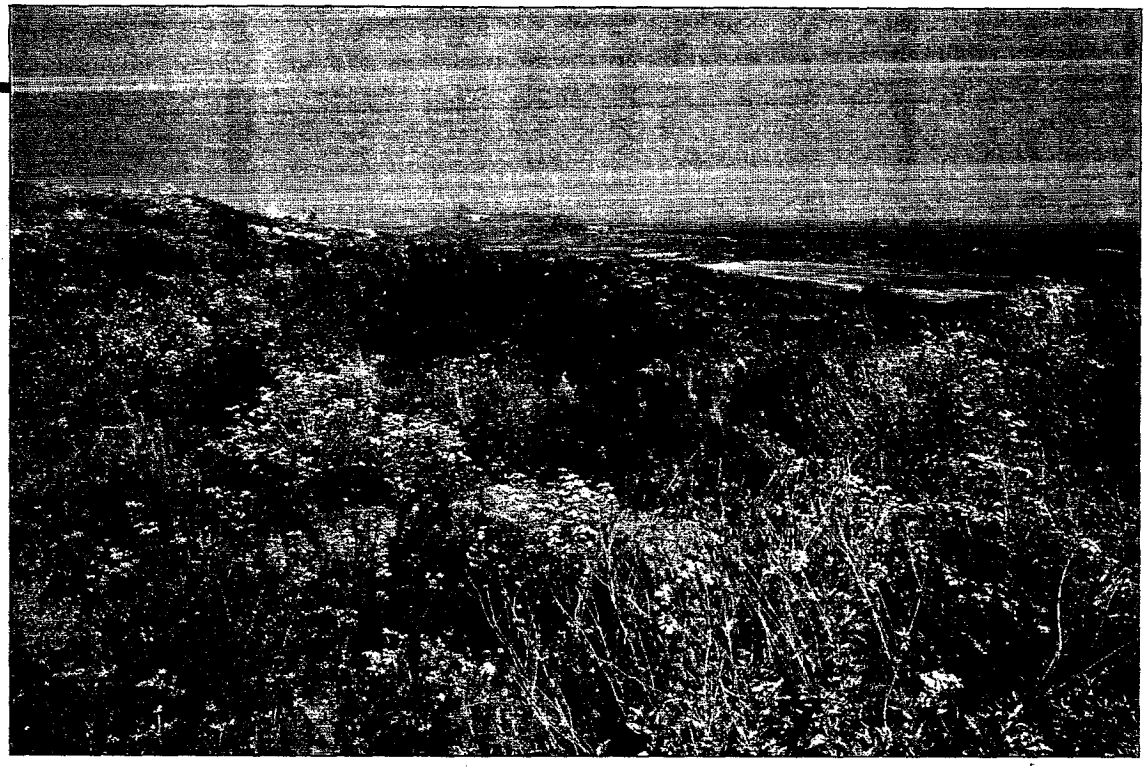
Local ballot measures. In 1990, Sonoma County residents voted to establish the Sonoma County Agricultural Preservation and Open Space District, which is funded by a quarter percent increase in the local sales-tax rate over a 20-year period. This public agency protects open space and agricultural land, focusing primarily on acquiring conservation easements on farmland. The district enjoys an annual funding stream of nearly $10 million and has protected more than 25,000 acres of land, the majority of which is agricultural. Local farmland conservation efforts throughout the state have taken note of Sonoma's effort and several Central Valley counties are seriously discussing forming agricultural land trusts as a first step in replicating the Sonoma model.

Future prospects

The prospect for the continued health and growth of agricultural land trusts in California is quite favorable for two reasons: funding to acquire conservation easements on agricultural land is likely to increase, and farmland owner support for agricultural land trusts is growing.

The Agricultural Land Stewardship Program. Created by state legislation in 1995 and administered by the California Department of Conservation, the Agricultural Land Stewardship Program provides grants for land trusts and local governments throughout the state to acquire conservation easements on agricultural land. Although initially funded for only $1 million in fiscal year 1996/97, the amount grew to $3.7 million in the governor's fiscal year 1998/99 budget. While this funding level is modest, the success of initial acquisitions and growing interest on the part of landowners will likely generate additional support to greatly expand the amount of funding available for farmland conservation efforts in California. The Agricultural Land Stewardship Program has already matched federal funding available from the 1996 Farm Bill's Farmland Protection Program. California has received nearly $2 million, which has been used to purchase conservation easements on farmland.

Acceptance of agricultural land trusts by farmers/ranchers. The most favorable sign that agricultural land trusts will continue to thrive and pros-



Courtesy of Riverside Land Conservancy

Riverside Land Conservancy advocates the preservation of open space such as this brittlebush-covered terrain in Riverside.

per is that agricultural landowners are beginning to accept and support them. An increasing number of farmers and ranchers serve on the boards of directors of agricultural land trusts. In addition, farmers and ranchers have become increasingly involved in recent discussions about the vital role that these trusts and conservation easements play in providing options for farmland conservation. These discussions have been held by groups such as the California Cattleman's Association and the Agricultural Task Force for the Central Valley, a private task force of prominent agriculturists seeking consensus of farmland conservation efforts.

Thanks to the ambassadorship of farmers and ranchers serving on agricultural land trusts' boards of directors, as well as the positive stories of landowners who have worked with them, agricultural land trusts and their conservation easement activities are meeting increasing favor from the larger agricultural community. The goodwill and favorable impression that landowners are left with after working with agricultural land trusts is highlighted by the fact that farmers and ranchers now perceive these organizations to be "accepted tools for farmland conservation" rather than "private property rights abridgement."

A great contributor to this increased support is the policy evolution of major agricultural organizations. The California Farm Bureau Federation, for example, has supported conservation easements and the role of agricultural land trusts for several years and was a strong supporter of the Agricultural Land Stewardship Program legislation. But this evolution is perhaps best illustrated by the Colorado Cattlemans' Association, which formed a land trust in 1995 to protect ranch properties throughout that state.

Conservation efforts expand

California's efforts to conserve agricultural land are expanding to new areas of the state and increasing their conservation easement activity. But these efforts will continue to be constrained by two factors: the level of interest in participating and the lack of available funding. Conservation easement programs will appeal only to a certain group of landowners, largely because many landowners are hesitant to place a permanent restriction on what is, for many, their primary asset. However, the limitation of funding is a far greater constraint. In a state with as much threatened agricultural land as California, it will take more than several million dollars a year to provide for more than a few farmland protection demonstration projects.

Even so, the potential for advancing farmland conservation efforts is great. Far from being solely involved in direct land protection, agricultural land trusts are also involved in efforts to educate public officials, landowners and the general public about the value of agriculture and the use of agricultural conservation easements as a tool to protect farmland in a community. In addition, agricultural land trusts are expanding their involvement into local policy efforts to protect farmland. All of these efforts supplement and support agricultural land trusts' primary function of permanently protecting important agricultural lands from urbanization.

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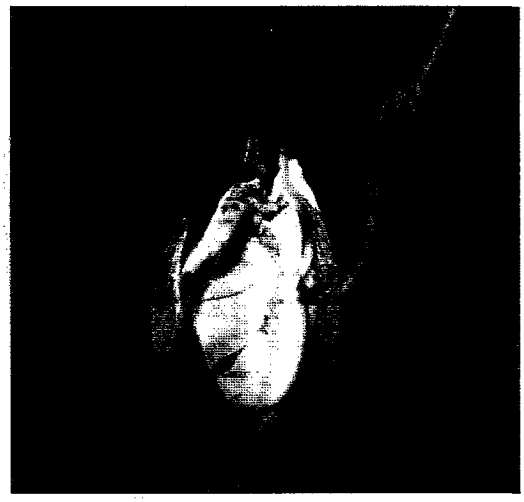
Fungal pathogen controls thrips in greenhouse flowers



Damage to 'Emblem' rose flower from thrips feeding.

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Western flower thrips cause considerable losses in a wide range of agricultural crops by feeding on leaves and fruit, laying eggs in fruit and transmitting diseases. Repeated pesticide application is currently the only method that reduces populations to acceptable levels. Biological control efforts have focused on using predators and have been largely unsuccessful. However, entomopathogenic fungi could also be used as biological controls for western flower thrips. Laboratory and field trials show that commercial formulations of* Beauveria bassiana *(GHA strain) can infect and reduce western flower thrips numbers in greenhouse floriculture crops, thus demonstrating its potential as an alternative to conventional pesticides.

The western flower thrips is one of the most significant pests of cut flower production in California. Thrips feed on flower petals, scarring them and causing aesthetic damage that can render the flowers unmarketable. For many flower crops, most of the pesticide sprays applied are to target thrips. The industry estimates pest control costs (labor and materials) to be 7.5% of total product costs. It is difficult to quantify the loss of flower production to thrips because the state doesn't keep statistics on it.

Infestations also cause considerable losses in a wide range of agricultural crops such as tomatoes, peppers, and stone fruits, by directly feeding on foliage and fruit and through ovipositional injury to fruit. In addition, western flower thrips serves as a vector for both tomato spotted wilt virus and impatiens necrotic spot virus, which attacks a wide range of floral and vegetable crops.

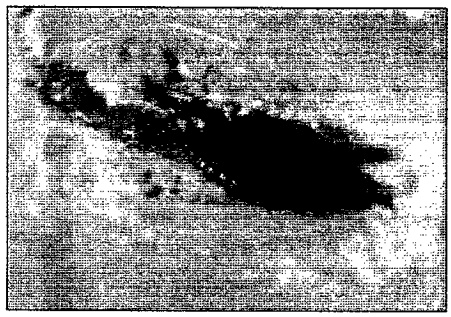
Current management tactics for western flower thrips (WFT), *Frankliniella occidentalis*, in floricultural production rely predominantly on repeated pesticide applications. In many situations, growers apply pesticides at 5-to-10-day intervals to reduce populations to acceptable levels. Such intensive use of pesticides has resulted in the widespread development of pesticide-resistant WFT in greenhouses. Efforts to reduce reliance on chemical controls have focused on biological control using predatory mites in the genera *Amblyseius* and *Hypoaspis* and predatory bugs in the genus *Orius*.

However, biological control alone has not succeeded in reducing thrips populations in floriculture crops to acceptable levels. The high demand for aesthetic quality and the problem associated with virus transmission make achieving successful control with natural enemies very difficult. Because the price of the commodity is linked to the aesthetic quality, growers tend to have a low tolerance for damage.

Another potential alternative to traditional pesticides is the use of entomopathogenic fungi, which grow on thrips and other arthropods. Naturally occurring fungal pathogens are lethal to many arthropod species. When the temperature and relative humidity are optimal, a large proportion of an insect population can become infected with the fungus, resulting in significant reductions in insect population size; this is called an *epizootic*.

The common occurrence of natural fungal epizootics has led to attempts to exploit fungi as a method of pest control in field and greenhouse crops around the world. To date, commercial use has been limited by technical difficulties with the mass production and shelf life of conidia (spores), formulation and variable performance among fungal species and strains, as well as the demanding environmental conditions required for fungal infection. Recently, however, advances in fermentation and formulation technologies and better isolation of infec-

Western flower thrips, *Frankliniella occidentalis* adult female and eggs.



Western flower thrips adult female showing the sporulating fungi of *Beauveria bassiana*, indicating the thrips was killed by the fungal infection.

tious species and strains have led several manufacturers to begin commercial production of fungi for pest control.

Fungal pathogens have several characteristics that make them ideal candidates for alternatives to chemical pesticides. Often fungi are relatively host specific, have low mammalian toxicity, can be cheaply mass-produced on artificial media and can infect a high proportion of the target population. In addition, fungi can be readily formulated and applied using standard spray equipment.

High temperature and relative humidity are required for most fungi. However, some newly discovered species and strains appear capable of infections over a wider range of environmental conditions commonly found in the greenhouse (60° to 85°F, 50 to 100% relative humidity). Although different life stages of fungi can be applied, the conidiospores (spores) are most often used as the agent of control. Insects can get spores on them either from direct spraying or from contacting plant foliage that has been sprayed. After becoming attached to a susceptible host, a spore grows a germ tube that penetrates the insect's cuticle. This enables the fungus to feed on the host's body, ultimately killing the insect.

Warm temperatures and relatively high humidities make greenhouses ideal environments for using fungal pathogens. Here, we present the results of laboratory and greenhouse trials designed to evaluate the potential of using a commercially produced strain of *Beauveria bassiana* for control of western flower thrips in greenhouse floriculture crops. Two commercial products containing the fungus are currently available: BotaniGard (a wettable powder [WP] or emulsifiable oil [ES] that is produced by the Mycotech Corp. of Butte, Montana) and Naturalis-O, (produced by Troy Biosciences Inc. in Lake Placid, Florida). In the experiments reported here, we used the BotaniGard WP and ES formulations of the fungus.

Laboratory and field trials

Laboratory trials. We conducted laboratory trials to assess the effectiveness of *B. bassiana* against mixed ages of adult male and female WFT on rose foliage at different spore concentrations under controlled temperature and relative-humidity conditions. Concentrations of 0.1, 0.45, 0.9 and 1.8 grams of spores (4.4 × 1,010 spores/gram) per 100 milliliters water plus a spreading agent (0.3% v/v, Silwet L-77) were tested on rose foliage against WFT and compared to WFT treated with the spreading agent alone. In addition, tests were conducted to compare the influence of three relative humidities (60%, 75% and 90%) on WFT mortality at two spore concentrations (0.9 and 1.8 grams spores per 100 mL water). WFT were confined on rose foliage within small cardboard cartons with a clear petri dish lid. Each carton represented an experimental replicate. Four replicates containing 20 to 50 adult WFT at each concentration and relative humidity were compared.

Approximately 0.6 milliliters of *B. bassiana* spore suspension was applied to rose foliage and WFT within cartons using a laboratory spray tower. Cartons were held in environmental chambers at 78.8°F (26°C) at one of the three relative humidities. The temperature and relative humidity in the vented cartons closely approximated those in the environmental chambers (within 3.6°F [2°C] and 5% RH). Every 24 hours for 7 days, we counted the number of dead WFT in each carton. Differences in the proportion WFT mortality among treatments were analyzed by ANOVA and mean comparisons between treatments were performed using Dunnett's method at $P = 0.05$. Probit analysis was used for estimating the dose-mortality relationships.

Caged rose trials. Initial tests evaluating the efficacy of a *B. bassiana* wettable powder (WP) against WFT adult females on flowering plants were performed on caged rose buds. In a commercial greenhouse, 16 rose bud replicate cages were used within a randomized complete block design. We sprayed 8 of the rose bud replicates with *B. bassiana* WP at 1 pound of formulation per 100 gallons of water plus a spreading agent (as discussed above) and sprayed the other 8 with water and spreading agent only, then allowed them to dry. Flower buds were then enclosed with a Mylar tube cage with a mesh screen at either end to allow for ventilation. We aspirated 12 to 15 adult female WFT from carnation flowers and released them into each of the cages.

After 7 days, cages were pruned from the rose bushes and returned to the laboratory and placed in a conventional freezer to kill WFT within the cages. Because of the high rate of activity of WFT, it is necessary to inactivate WFT to obtain accurate counts. We then dissected the flower buds and recorded the number of adult and larval WFT. The WFT recovered from cages were then emersed in alcohol to kill spores on the insect cuticle and plated on a selective agar medium to determine the degree of fungal infection within WFT among treatments.

Commercial greenhouse trials

Field studies were conducted at two locations: Watsonville and Half Moon Bay. Trials compared the performance of the *B. bassiana* wettable powder

(WP) and an emulsified oil (ES) formulation of *B. bassiana*.

Carnations. The Watsonville trial was conducted against WFT in a 40,000-square-foot greenhouse in three carnation cultivars — 'Elegance', 'Etna' and 'Bagatel'. Test plots consisted of 3 treatments with 6 replicates for each treatment (approximately 725 square feet per plot for a total of 13,050 square feet). Six plots were treated with *B. bassiana* wettable powder (WP) formulation (1 lb/100 gal), 6 plots were treated with *B. bassiana* emulsifiable oil (ES) formulation (2 qt/100 gal) and 6 plots were untreated controls. The mean number of WFT residing in the carnations was counted just prior to the beginning of the trial. Two applications were made 8 days apart, the first on Nov. 28 and the second on Dec. 6, 1995. To compare mean WFT densities among plots, we sampled 10 to 15 fully opened carnation flowers from each plot on Dec. 6 and 13.

Roses. The Half Moon Bay trial was conducted against WFT within a 50,000-square-foot, commercial fresh-cut rose greenhouse in two rose cultivars, 'Royalty' and 'Caramia'. The trial consisted of three treatments, the first was *B. bassiana* WP (1 lb/100 gal), the second *B. bassiana* ES (2 qt/100 gal) and the third was an emulsifiable oil carrier only as the control (2 qt/100 gal).

The trial was designed as a randomized complete block design using 12 test plots of approximately 1,185 square feet each. Each of the two blocks consisted of 6 plots; treatments were randomly assigned to all plots within each block. There were four replicates per treatment. A one-row buffer was maintained between each treatment plot to minimize drift from spray applications. We monitored WFT densities just before and after treatment by sampling 10 rose flowers per plot. Four treatment applications were made at 7-day intervals beginning on April 3, 1996, and ending on April 24, 1996.

For both the carnation and rose field trials, we bagged flower samples individually to prevent movement of WFT between samples. Samples were returned to the laboratory and kept in a conventional freezer until processing. We dissected WFT from rose or carnation flowers and recorded the total number. For the rose trial, 5% chlorine bleach was used to kill any spores on the insect cuticle and plated the WFT on selective agar to determine the rate of fungal infection. Differences in WFT mortality among treatments in the caged rose and commercial trials were analyzed by ANOVA and mean comparisons between treatments were performed using Tukey's mean separation test at $P = 0.05$.

Reductions in thrips numbers

Laboratory trials. Results of the laboratory trials revealed that *B. bassiana* WP applications caused significantly greater WFT mortality at all concentrations when compared to controls at 78.8°F (26°C) and 75% relative humidity (table 1). WFT mortality did not exceed 90% for any single concentration tested. Therefore, we estimated the optimal concentration resulting in 50% WFT mortality. Probit analysis determined that *B. bassiana* WP killed 50% of the WFT population at a concentration of 0.42 grams per 100 milliliters of water (table 1). This concentration is the equivalent of applying 20 trillion spores per acre (1 lb *B. bassiana* WP). Doubling the concentration first to 0.9 grams/100 milliliters and then again to 1.8 grams/100 milliliters, did not double the mortality rate, indicating that the initial concentration of 0.45 grams/100 ml yielded close to the maximum mortality at this temperature and relative humidity.

Relative humidity tests revealed that significant mortality occurred at all relative humidities tested; however, the degree of mortality was shown to increase with increasing humidity (table 2). Relative humidities in California greenhouses vary depending on geographical region and greenhouse type but typically range between 50 and 100% within a 24-hour period. The laboratory results confirmed that humidity is an important factor influencing the degree of WFT control but use of either formulation should significantly reduce WFT numbers under California greenhouse conditions.

Caged rose trial. Results of the caged trials confirmed that *B. bassiana* applications to rose buds infested with WFT can result in significant reductions in WFT numbers. The magnitude of the reduction was similar to that found in the laboratory bioassays.

Initial WFT counts within cages revealed that control cages averaged 16.5 +/- 3.35 WFT and that cages treated with *B. bassiana* WP averaged

TABLE 1. Dose-mortality tests of *B. bassiana* wettable powder (WP) against adult western flower thrips *Frankliniella occidentalis* at 78.8°F (26°C), 75% relative humidity

Concentration*	Mortality†	Lethal Concentration (95% confidence limit‡)
	%	
0.10 gms / 100 ml	29.2	
0.45 gms / 100 ml	51.1	LC10 0.0148 (0.00012–0.05742)
0.90 gms / 100 ml	62.0	LC50 0.4180 (0.1866–0.8350)
1.80 gms / 100 ml	82.0	LC90 11.81 (3.2900–1089.1)

*4.4×10^{10} spores per gram.
†Mortality significantly different among treatments ($F = 8.5$; df = 3,15; $P = 0.002$), all treatment means greater than control using Dunnett's method $P < 0.05$; percent mortality at 7 days, corrected for control mortality using Abbotts's correction, which assumes control mortality is zero.
‡Result of Probit analysis.

TABLE 2. Effect of relative humidity on the 7-day mortality of western flower thrips at two *B. bassiana* WP dosages

	Relative humidity		
	60%	75%	90%
Concentration*	Mortality†		
	%		
0.9gm	40.8	57.4	80.0
1.8gm	47.5	86.5	97.1

*4.4×10^{10} spores per gram.
†Corrected for control mortality using Abbotts's correction.

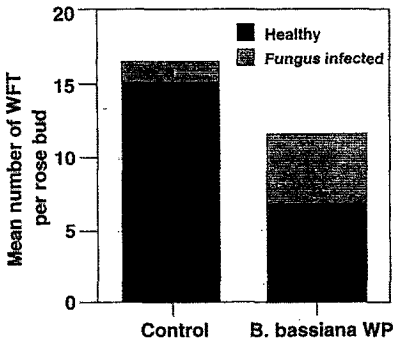


Fig. 1. Mean number of fungus-infected and healthy western flower thrips in caged rose buds in untreated control and *B. bassiana* WP-treated cages. Treatment means separated by different letters are significantly different (Tukey's mean separation test, P < 0.05).

11.5 +/- 2.58 (fig. 1). Differences in the average number of WFT within cages were not significantly different between treatments (P > 0.05). However, at the time of collection it was observed that most WFT in the treated cages were dead while most in the control cages were living. By plating all WFT cadavers on agar medium, we determined that *B. bassiana* infection was present in 42.4% of the WFT in the *B. bassiana*-treated cages whereas only 8.3% in control cages were infected.

After subtracting the number of fungus-infected individuals from the total number of thrips, the net number of WFT that were uninfected was 6.6 +/- 1.67 for the *B. bassiana*-treated cages and 15.1 +/- 3.25 for the control cages. Therefore the number of surviving WFT in the cages were 56% lower in the *B. bassiana*-treated cages relative to the control cages. Differences in the remaining uninfected WFT between treatments were significant (F = 5.98; df = 2, 15; P = 0.029).

Commercial carnations. Prior to treatment applications, Mean WFT in carnation flowers among plots were not significantly different (fig. 2). After the first treatment, WFT numbers increased in all plots presumably due to WFT moving into the greenhouse. For the first postspray sample period, WFT numbers were significantly lower in the *B. bassiana* ES plots than in the control plots, but not in the *B. bassiana* WP plots. By the second postspray period, WFT numbers had begun to drop in all plots. WFT numbers were significantly lower in *B. bassiana*-treated plots than in the control plots (fig. 2): WFT numbers were 59% lower in ES plots and 72% lower in WP plots. Fungal infection data for WFT were not available for the carnation trial. During the trial, greenhouse temperatures averaged between 50° and 82°F (10.0°C and 27.8°C) and the relative humidity ranged between 45% and 80% during a 24-hour cycle.

Commercial roses. Pretreatment WFT numbers showed average WFT densities were approximately even among treatment plots prior to applications (fig. 3). During the first postspray sample period, significantly fewer WFT were detected in the *B. bassiana* ES plots relative to control plots, but the numbers in the *B. bassiana* WP plots were not significantly lower than the control. By the second postspray sample, WFT numbers were also significantly lower in *B. bassiana*-treated plots than in control plots: WFT were 83% lower in ES plots and 75% lower in WP plots. Thereafter, WFT numbers in the *B. bassiana* plots remained below 1 WFT per rose bud. During the trial, greenhouse temperatures averaged between 60°F and 90°F (15.5°C and 32.2°C) and the relative humidity ranged between 45% and 100% during a 24-hour cycle.

Pretreatment examination of WFT showed that there was a low-level natural infection of a Beauveria species similar to *B. bassiana* (data not shown). However, morphological differences between the fungal species allowed us to distinguish them. The fungal infection rates during the trial revealed the presence of infected WFT in all treatments, including the controls. However, the rate of infection was significantly greater in the *B. bassiana* treatments (fig. 4) except for the WP plot on April 17. We suspect that the fungal infection in the control plots was the result of infected adult WFT dispersing from the *B. bassiana*-treated plots.

Commercial fungus kills thrips

Western flower thrips is a key pest of most floriculture crops. Without viable alternatives for WFT control, the only means to prevent damage is

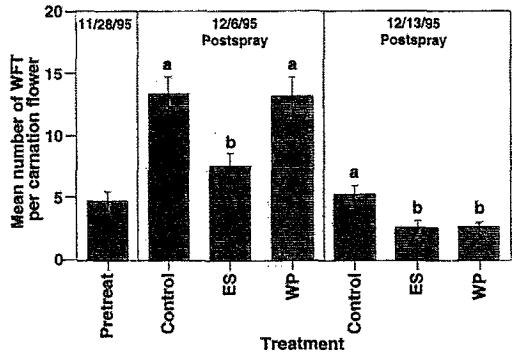


Fig. 2. Mean number of healthy WFT in carnation flowers for untreated controls and *B. bassiana* WP-treated and *B. bassiana* ES-treated plots. Treatment means separated by different letters are significantly different (Tukey's mean separation test, P < 0.05).

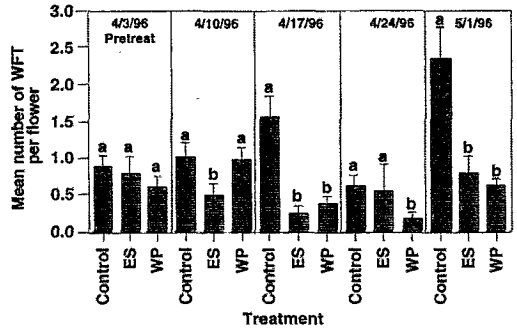


Fig. 3. Mean number of healthy WFT in rose buds for emulsified oil controls and *B. bassiana* WP-treated and *B. bassiana* ES-treated plots. Treatment means separated by different letters are significantly different (Tukey's mean separation test, P < 0.05).

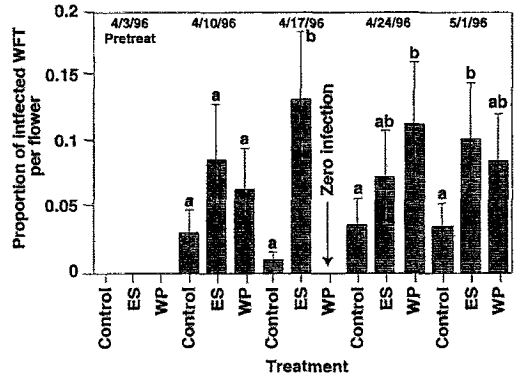
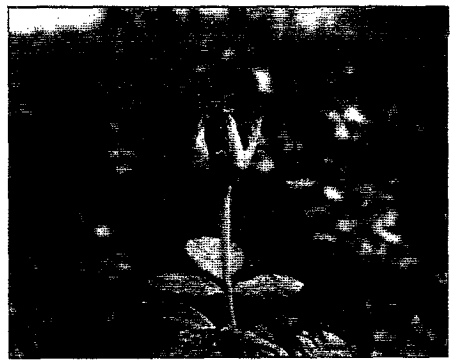


Fig. 4. Mean proportion of fungus-infected WFT in rose buds for emulsified oil controls and *B. bassiana* WP and *B. bassiana* ES-treated plots. Treatment means separated by different letters are significantly different (Tukey's mean separation test, P < 0.05).



▲ 'Caramia' rose bud ready for harvest.

◀ Application of fungal spores to greenhouse fresh cut roses using standard spray equipment.

through repeated pesticide applications. Residues from repeated pesticide applications targeting WFT often kill natural enemies of other greenhouse pests and therefore may both contribute to secondary pest outbreaks and interfere with adoption of IPM tactics such as biological control. The lack of effective alternatives to traditional pesticides for WFT control has therefore led to over-reliance on pesticides in greenhouses despite increasing costs and other negative secondary effects. The performance of *B. bassiana* in this study indicates that fungal pathogens could be substituted for some pesticide applications.

Laboratory and caged rose trials demonstrated that commercial formulations of *B. bassiana* can infect WFT and reduce populations in the greenhouse. Reductions were variable, ranging from 50 to 97%. Similar results were seen in both the commercial carnation and rose trials. In a greenhouse setting, it is difficult to prevent infected WFT from contaminating control plots; as a result, the percentage of control achieved with *B. bassiana* in the commercial trials should be considered conservative estimates.

Fungal infection is sensitive to environmental conditions. Increases in temperature or, particularly, relative humidity can influence the rate of fungal infection and the degree of WFT control achieved. Trials with commercial growers demonstrated that good performance could be obtained under commercial growing conditions that include the temperature and relative humidity regimes typical of greenhouses. Differences in performance between the two formulations were evident in both greenhouse trials. The oil formulation of *B. bassiana* reduced WFT numbers within the first week while the wettable powder required up to 2 weeks. The reason for this difference is currently being investigated. Our results thus far indicate that while both commercial formulations of *B. bassiana* could be used to help control WFT in greenhouse flowers, the ES formulation works more quickly. Growers tolerate very few WFT in their flowers; based on these studies, *B. bassiana* is capable of reducing WFT in flowers to very low levels, generally within growers' tolerable range.

Although the results so far are encouraging, several limitations are of concern. First, fungal pathogens kill host insects more slowly than insecticides and therefore must be applied earlier in the appearance of WFT to maintain the thrips at low levels. Second, under severe immigration pressure, the movement rate of WFT into the crop can exceed the rate of fungal infection and acceptable reductions may not be achieved soon enough to prevent damage. Finally, spores kill insects through direct contact with their hosts, therefore, good coverage is essential to achieve adequate control.

Commercial field trials in rose, poinsettias and chrysanthemums for WFT and whitefly control are currently under way to further develop user guidelines for *B. bassiana*. These trials are aimed at estimating the optimal field dosage rate, spray intervals and evaluating the combined use of *B. bassiana* with other insecticides as well as with natural enemies.

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◀ Farm advisor emeritus Walt Graves compares 7½-year-old green medic rows with short, dried-out annual grasses. Certain medics yielded more than annual grasses did.

Legumes show success on Central Coast rangeland

William H. Weitkamp ❑ Walter L. Graves

Improvements for rangeland and ley farming systems must be economical and long-lasting if they are to be used by ranchers in low-rainfall areas of California. Commercial and research seedings of annual legumes dating back to the 1970s and 1980s prove that certain medic varieties can be established economically and will remain productive for decades on rangelands with neutral to basic soils. In a 12-year variety trial conducted in eastern San Luis Obispo County, 13 of 18 medics survived.

The Camatta Ranch, located 25 miles east of Santa Margarita, is typical of many eastern San Luis Obispo County ranches that once had large acreages farmed to dryland barley and wheat. These crops were usually marginal and prices low. Soils became poorer with repeated tillage, and federal farm programs eventually shifted from production to conservation incentives. In the late 1980s, 100,000 acres in San Luis Obispo and southern Monterey counties were taken out of farming and enrolled in the Conservation Reserve Program (CRP).

Although only limited grazing has been allowed on CRP acreage to date, it is likely that the best use of most of the worn-out farmland now and in the future is for livestock grazing and wildlife habitat. Introducing annual legumes, which use elemental atmospheric nitrogen to make proteins (a process called nitrogen fixation), can improve quality and quantity of forage for animals. And, on land that is suitable for farming, a well-managed program of rotating the grazing of legumes by sheep or cattle with grain farming (called *ley* farming) can improve the soil while increasing livestock and grain production. But improvements for rangeland and ley farming systems must be economical and long-lasting if they are to be used by ranchers in low-rainfall areas of California.

Camatta Trial 1

To test the establishment, survival and production of annual legumes, 24 varieties and collections of medics and clovers were seeded on the Camatta Ranch in October 1985. Seed was inoculated using the Pelinoc method and broadcast on plots measuring 4 feet square in dryland grain stubble. We also broadcast phosphate fertilizer (0-25-0-10) on the plots at the rate of 400 pounds total material per acre. Average annual rainfall at the trial location is approximately 7 to 8 inches, and the soil is Balcom clay loam with a pH of 7.5, within the desirable range for medics. Seed for 18 medics and 6 clovers was provided by author Walter Graves, who made collections in the Mediterranean region. The varieties came from Australian seed companies.

The season following the October 1985 seeding was excellent for plant germination and growth, with rains beginning in November and totaling 10 inches by the following April. Subsequently there were 4 consecutive dry years, which averaged less than 6 inches of effective rainfall. From then through 1997, annual rainfall patterns and totals varied extremely.

Plots were grazed by cattle during the spring of 1986 and the field was then entered into the CRP with no livestock grazing allowed for 10 years. At the time of the 1997 ratings referred to below, grazing had not resumed.

The plots were rated for stand and vigor (1 = poor, 10 = excellent) the first spring after seeding (1986) and the twelfth spring after seeding (1997) (table 1). Data was analyzed using an analysis of variance; Duncan's multiple range was used to test for differences between means for each year.

Thirteen of 18 medics survived for 12 years, with Serena bur medic rating 9 and four others rating 7 or higher. These five best medics in 1997 were rated at least 6 in 1986, while the 10 medics that rated 5 or lower in 1986 also rated 5 or lower in 1997. So a strong start the first year appears to be desirable for long-term high regeneration and vigor in medics. But a strong start is not a guarantee of repeated dense stands and high vigor; some of the medics started with medium to high ratings and dropped off considerably by 1997.

Serena bur and Sephi barrel medics were commercial varieties that had performed well at other locations, so their high ratings were no surprise. The other three medics that rated 7 or higher were less predictable because

they were collections from the Mediterranean region and had no track record in this part of California. Collections of *Medicago laciniata* Krakra (Krakra cutleaf medic), *M. laciniata* 6 and *M. scutellata* 8121 (snail medic from Tunisia) seem to be good candidates for expansion because they had high ratings and were the only survivors in their species in 1997.

The only trifolium variety that appeared to be adapted to the trial site was Yamina cup clover, which rated 6.3 in 1997. High soil pH and low rainfall probably contributed to failure of the other trifoliums. However, commercial varieties of subterranean clovers have persisted well in other areas of the Central Coast, where annual rainfall is about 15 inches or more.

Camatta Trial 2

In an adjoining trial, 10 commercially available medic varieties were seeded and fertilized at the same time as Trial 1 (October 1985) in plots 12 feet square. Ratings made in 1986 and 1997 were analyzed using an analysis of variance; Duncan's multiple range was used to test for differences between means for each year. Serena bur and Sephi barrel persisted (table 2), but their stands were not as dense as in Trial 1. Hannaford barrel and Jemalong barrel, not included in Trial 1, had the highest ratings in Trial 2. Circle Valley bur, also not in Trial 1, equaled Serena bur in Trial 2.

The gama medics — Sapo, Paragosa and Paraponto — persisted, although their respective ratings of 2.7, 1.7 and 0.7 were not impressive. As in Trial 1, Robinson snail medic did not survive.

Camatta drill seedings

During the same month that Trials 1 and 2 were planted (October 1985), the ranch foreman seeded about 20 acres of a medic mix near the trial plots and in other widespread areas of the ranch with a 5-foot range drill. Approximately 8 pounds of seed and 100 pounds of phosphate fertilizer (0-25-0-10) per acre were applied in shallow disk furrows. No additional fertilizer has been applied since this seeding. Jemalong barrel, Hannaford barrel, Paragosa gama, Serena bur and Circle Valley bur medics were in the mix.

In areas with high pH, calcareous soils, such as the Balcom clay loam at the trial sites, barrel and bur medics have persisted throughout the 12-year period and have been very productive during average or better rainfall years. Only Paragosa gama medic has not performed well.

To illustrate the range in forage production increases due to annual medics, we clipped paired plots of 1 square foot each on May 4, 1993, in four drill-seeded locations and in four nonseeded locations immediately adjoining drill rows. Side-by-side comparisons were possible because medic plants had not spread far from the drill rows, apparently due to limitations in the spread of seed, rhizobium inoculant or both. Plots with no medics consisted mainly of annual grasses such as squirreltail fescue and red brome. This was a demonstration exercise for a field day, not a scientific experiment. Similar results should not be expected on all sites, especially where resident legumes are well established.

Rainfall was favorable for plant growth during the 1992–1993 season, as indicated by the yields on the best site — 8,256 and 3,552 pounds dry forage per acre (table 3). Yet grasses on the poorest site of this sampling produced only 384 pounds, while the medics yielded 2,592 pounds, nearly 7 times more high-protein forage. Yield differences between medics and grasses ranged from 2,208 pounds for this poor site on a hilltop up to 4,800 pounds for Site 1.

From observations made during drought years, it appeared that the percentage increase in forage production due to medics was at least as great then as in 1992–1993. The increase in pounds of forage per acre, however, was less than during the wetter year.

Perhaps more important, protein content of medic forage is higher than

TABLE 1. Camatta Ranch Trial 1: legume varieties and collections, plot size: 4 feet x 4 feet

Seeding date: Oct. 28, 1985	**Fertilization: 0-25-0-10 @ 400 lb per acre**
Number of replications: 3	**Soil: Balcom clay loam**
Seeding rate: 50 lb per acre	**Soil pH: 7.5**
Location: Camatta Ranch, east of Santa Margarita	**Inoculant: Pelinoc**

Legume Common or collection name (Genus and species)	Stand and vigor rating (1 = poor, 10 = excellent) 4/22/86	3/31/97
Serena bur medic *(Medicago hispida)*	8.0 ab*	9.0 a*
Krakra cutleaf medic *(M. laciniata)*	7.7 abc	7.3 ab
Sephi barrel medic *(M. truncatula)*	7.0 bcd	7.0 ab
6 cutleaf medic *(M. laciniata)*	6.3 cde	7.0 ab
17 bur medic *(M. hispida)*	6.0 def	7.0 ab
8121 snail medic *(M. scutellata* - Tunisia)	6.0 def	6.7 abc
Yamina cup clover *(Trifolium cheleri)*	4.3 ghi	6.3 abcd
604 bur medic *(M. hispida)*	8.7 a	6.0 abcd
97 bur medic *(M. hispida)*	7.7 abc	5.7 abcd
17H/S gama medic *(M. rugosa)*	3.0 ijkl	4.7 abcde
Paraggio barrel medic *(M. truncatula)*	4.7 fgh	3.3 bcde
Paragosa gama medic *(M. rugosa)*	4.3 ghi	2.3 cde
Paraponto gama medic *(M. rugosa)*	2.0 lmn	2.3 cde
Sapo gama medic *(M. rugosa)*	3.7 hijk	2.0 de
Beenong cup clover *(T. cheleri)*	2.3 klmn	0.7 e
Sava snail medic *(M. scutellata)*	2.7 jklm	0.3 e
14H/S Calvary medic *(M. ciliaris)*	5.3 efg	0†
135 Calvary medic *(M. ciliaris)*	4.7 fgh	0†
Robinson snail medic *(M. scutellata)*	4.7 fgh	0†
GR301 sub clover *(T. subterranean)*	4.0 ghij	0†
11H snail medic *(M. scutellata)*	2.3 klmn	0†
400 sub clover *(T. subterranean)*	2.3 klmn	0†
Nungarin sub clover *(T. subterranean)*	1.3 mn	0†
GR812 sub clover *(T. subterranean)*	1.0 n	0†

* Values within columns with different letters are significantly different, $P \leq .05$
† Varieties with 0 ratings (not present) in 1997 were omitted from statistical analysis.

***Above*, drill-seeded medics on Camatta Ranch in 1991. The bur and barrel medics were productive and persisted throughout the 12-year study. *Right*, a medic mix was drill-seeded in barley stubble. Grain or hay stubble provides a good seedbed for establishing medics.**

in annual grasses, especially after the grasses have headed out. In addition, medic seed pods, which are usually produced in abundance, are more palatable to livestock and provide more energy and protein than dry grasses during the summer. Local livestock managers are familiar with the nutritional value of resident annual medics such as bur clover. This benefit can be extended to many rangelands of neutral to basic pH in California by planting drought-tolerant medics where rainfall is too low for resident bur clovers.

Although livestock were excluded after the 1985-86 season from the CRP field where the first two trials were located, drill seedings included fields that were grazed every year. One small field included a portable corral and was heavily grazed by cattle. Medics, especially Serena bur medic, persisted as well here as in the CRP field, and the ground is covered with medic seed pods at the beginning of each summer. On many range sites, grazing is necessary for medic stands to remain productive because competing grasses and weeds will otherwise dominate due to a buildup of soil nitrogen from nitrogen fixation by the medics.

Medic regeneration

A survival characteristic of annual medics and many other annual legumes is their ability to regenerate from seed even after years of adverse weather conditions. This is due to abundant seed production and the presence of a high percentage of hard seeds, which remain dormant for 1 or more years before germinating.

An example of this survivability is a grain field near Cholame that was planted to a 6-pound mix of Jemalong barrel medic and Hykon rose clover in the fall of 1971. Because this was in a low-rainfall area with high pH soils, similar to the Camatta Ranch, only the medic survived and improved year by year to a fair stand. After being grazed for several years, the field was planted to cereal grains again and then allowed to return to rangeland, with no reseeding by the 1980s.

This time the medic stand became dense and, when forage plots were clipped in April 1983 — a high-rainfall year — dry matter weighed 5,875 pounds per acre. The ley farming treatment had apparently improved the medics. In 1984, the medic seed reserve in the soil was sampled and estimated to be 500 pounds per acre; not a bad return on the few pounds per acre that were seeded in 1971. In 1997, the field is still in medics and is grazed by dairy replacement heifers.

TABLE 2. Camatta Ranch Trial 2: legume varieties and collections, plot size: 12 feet X 12 feet

Seeding date: Oct. 23, 1985
Number of replications: 3
Seeding rate: 20 lb per acre
Location: Camatta Ranch, east of Santa Margarita
Fertilization: 0-25-0-10 @ 400 lb per acre
Soil: Balcom clay loam
Soil pH: 7.5
Inoculant: Celpril

	Stand and vigor rating (1 = poor, 10 = excellent)	
Legume	4/22/86	3/31/97
Hannaford barrel medic	3.0 bc*	6.3 a*
Jemalong barrel medic	3.3 bc	5.3 ab
Circle Valley bur medic	2.7 cd	5.0 ab
Serena bur medic	1.7 de	5.0 ab
Paraggio barrel medic	3.7 bc	3.3 abc
Sephi barrel medic	7.0 a	2.7 bcd
Sapo gama medic	1.0 e	2.7 bcd
Paragosa gama medic	1.0 e	1.7 cd
Paraponto gama medic	1.3 e	0.7 cd
Robinson snail medic	4.0 b	0.0 d

*Values within columns followed by different letters are significantly different, $P \leq .05$. Duncan's multiple range was used to test for differences between means.

Medics survive test of time

In areas with as little as 7 to 8 inches of rainfall per year and soils with a neutral to basic pH, seedings of annual barrel and bur medics have survived the test of time — from 12 to

TABLE 3. Camatta Dry Matter Yield Comparisons: 1985 drill-seeded medic strips (approximately 8 lb of medic seed and 100 lb of 0-25-0-10 fertilizer per acre) versus resident annual grasses next to drill strips. Clipped in plots 1-foot square May 4, 1993, weighed after air drying.

Site	Medics	Annual grasses
	lb per acre	
1	5,856	1,056
2	7,200	3,360
3	2,592	384
4	8,256	3,552
Average	5,976	2,088

26 years. Annual yields of forage and seed have varied with rainfall amount and pattern, but high-yielding stands continue to be produced during favorable years. Forage production is much higher than in surrounding unseeded areas, even though no fertilizer was applied to any of the seedings after the first year. Medics persisted with or without grazing and, in at least one case, when land was farmed to grain between years of grazing. Improvements in quality and quantity of range forage can be extended to many rangelands of California by planting drought-tolerant annual medics where rainfall is too low for resident bur clovers.

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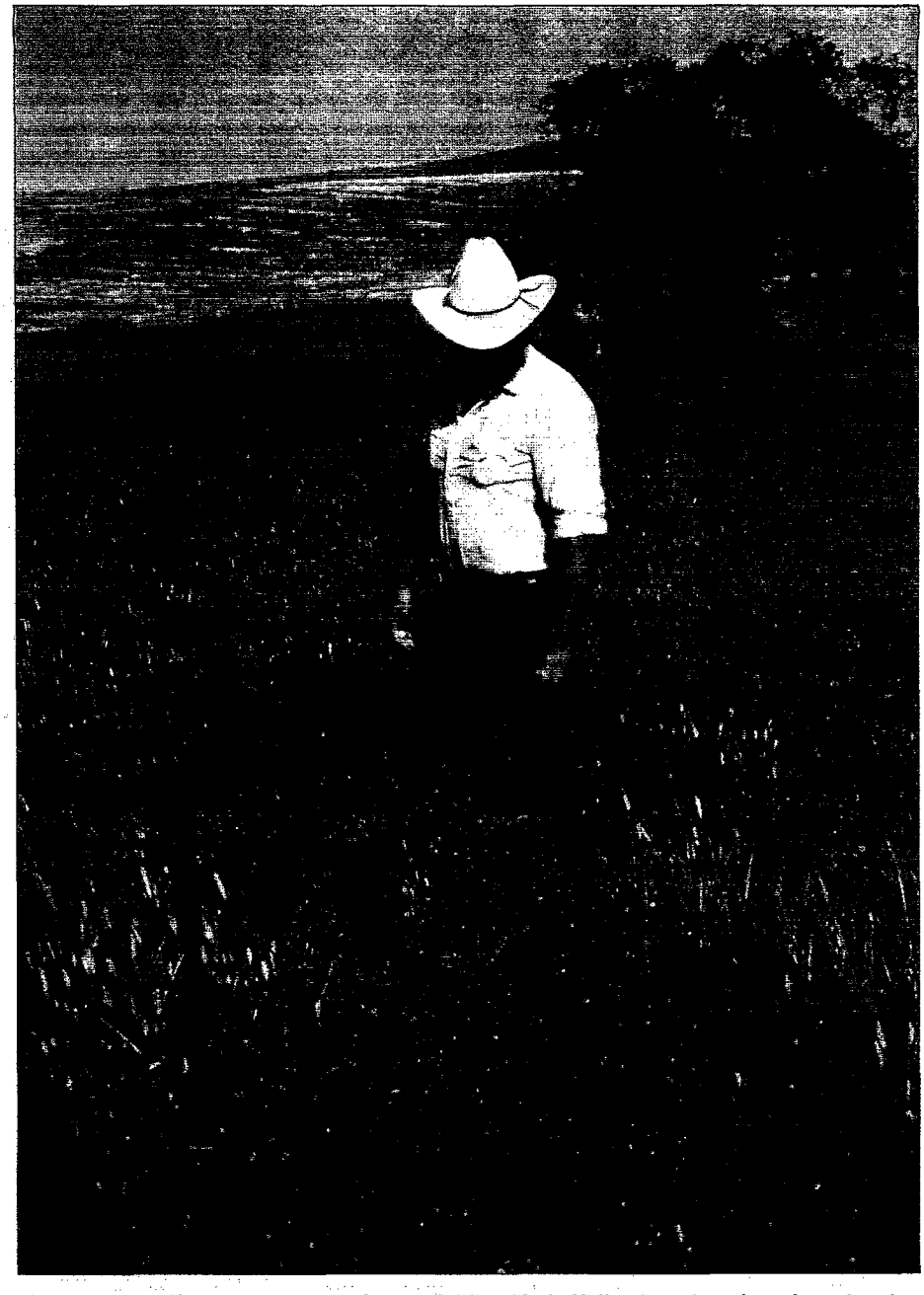

Farm advisor Michael Smith examines a field of Circle Valley bur, Jemalong barrel and Paragosa gama medics seeded in barley stubble. Annual medics are able to regenerate from seed even after years of adverse weather.

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